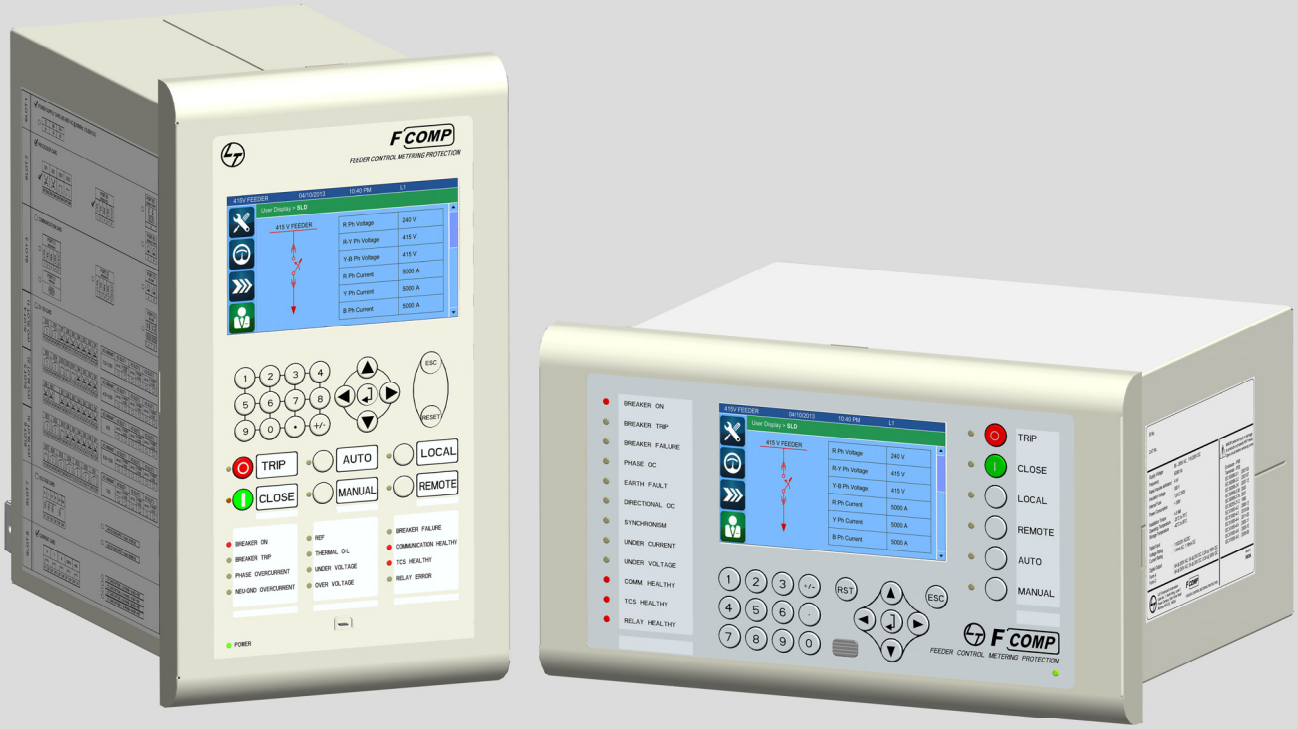
F COMP

FEEDER CONTROL METERING PROTECTION

INSTRUCTION MANUAL



L&T Electrical & Automation
Projects

Instruction Manual

FCOMP

Complete Solution for Feeder Protection

Rev. B

Release Date – January 2015

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Chapter 1

PREFACE

Manual Overview

FCOMP Instruction Manual provides complete information necessary to install, operate, and maintain FCOMP Relay.

An overview of this manual is as follows:

- **Preface:** Describes the manual organization, safety & general Information and conventions & nomenclatures used.
- **Introduction:** Provides a brief overview of the product and the manual.
- **Specifications:** Lists Relay specifications.
- **Installation**: Describes mechanical installation and electrical wiring of Relay.
- **Metering & Monitoring**: Describes the operation and calculation of each metering functions.
- **Protection**: Describes the operating characteristics of each protection element provided in Relay.
- **Communication**: Describes communication interface and protocols supported by Relay.
- **Setting Sheet**: Provides information about all settings available within Relay for field usage.
- **User Interface:** Describes how to enter and record settings for basic protection, and also provides the information about Relay configuration through local interface using COMPfigurator™.
- **Testing & Troubleshooting:** Describes the common problems encountered during testing & commissioning of Relay and various troubleshooting techniques.

Version

This is revision B release of the manual by Larsen & Toubro Ltd.

Purpose of This Manual

This manual intends to help the following users of the FCOMP Relay, to operate, maintain and troubleshoot the device.

- Design Engineers
- System Integrators
- Maintenance Engineers

Safety and General Information

This manual uses following safety statements:

Table 1-1: Safety Information

 DANGER	Immediate Hazard. SEVERE personal injury or death WILL result.
 WARNING	Hazards or unsafe practices. SEVERE personal injury or death MAY result.
 CAUTION	Hazards or unsafe practices. MINOR personal injury or damage to products or property MAY result.
IMPORTANT	Essential advisory information.
NOTE	Additional or explanatory information.

Conventions and Nomenclature

Conventions

In this manual,

Relay refers to FCOMP Unit

Nomenclature

Following are the different Nomenclature and their descriptions used in this Manual.

Table 1-2: Nomenclature and description

Nomenclatures	Descriptions
AC	Alternating Current
CB	Circuit Breaker
CBCT	Core Balanced Current Transformer
CT	Current Transformer
DC	Direct Current
DCS	Distributed Control System
DI	Digital Input

Nomenclatures	Descriptions
DO	Digital Output
ETH	Ethernet Protocol
FO	Fiber Optic
FSC	Fiber Optic Subscriber Connector
FST	Fiber Optic Subscriber Terminator
GPS	Global Positioning System
HMI	Human Machine Interface

Nomenclatures	Descriptions
HV/MV	High Voltage / Medium Voltage
IDMT	Inverse Definite Minimum Time
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Devices
IEEE	Institute of Electrical and Electronics Engineers
I0	Zero sequence Current
I1	Positive Sequence Current
I2	Negative Sequence Current
LCD	Liquid Crystal Display
LED	Light Emitting Diode
O/C	Over Current
O/L	Overload
OV	Over Voltage
PLC	Programmable Logic Controller
PT	Potential Transformer
PTC	Positive Temperature Co□efficient
R0	Nominal Resistance
REF	Restricted Earth Fault
RMS	Root Mean Square

Nomenclatures	Descriptions
RT	Resistance at temperature T
RTC	Real Time Clock
RTD	Resistance Temperature Detector
RTU	Remote Terminal Unit
SC	Subscriber Connector
SCADA	Supervisory Control and Data Acquisition
PMS	Power Management System
SCR	Silicon Controlled Rectifier
SEF	Sensitive Earth Fault
SNTP	Simple Network Time Protocol
ST	Subscriber Terminator
THD	Total Harmonic Distortion
TMS	Time Multiplier Setting
TOC	Timed Over Current
USB	Universal Serial Bus
UV	Under Voltage
V0	Zero sequence voltage
V1	Positive Sequence Voltage
V2	Negative Sequence Voltage

Suggestions for Improving this Manual

For any feedback to improve this manual and its contents, kindly contact our L&T Representatives at ESE-CMT@lntebg.com.

Chapter 2

INTRODUCTION

About L&T

Larsen & Toubro (L&T) is a technology-driven company that infuses engineering with imagination. The Electrical & Automation Group of L&T offers a wide range of advanced solutions through its state-of-the-art products, backed by world-class in-house capabilities in technology development and customer support.

Numerical Relays

The concept of employing numerical Relays for substation switchgear protection has existed since three decades. This has now matured into a stable alternative to conventional Electromechanical & Electromagnetic Relays. Historically, the need for numerical has evolved, and is driven by the following factors:

- Numerical Relay provides closer and more accurate protection to Switchgear Feeder assemblies.
- Earlier models of Numerical Relays were basically Electronic Microcontroller-based single function devices. With the advent of Microprocessor technology, such Relays now come with Microprocessors, which can be programmed to support multi-stage protections, to monitor the behavior of feeders under starting, short or prolonged running & inrush due to Cold Load pickup and various other anomalous conditions of feeder operation.
- These Relays come with Digital Inputs & Digital Outputs, which monitor the status of various wired inputs (DI) approaching Relay from external points, and exiting from Relay to the coil of the Circuit Breaker as Digital Outputs. Today, multiple combinations of interlocking the Digital Inputs & Digital Outputs through logic gates help substitute and achieve conventional interlocks & complex scheme logics, thereby eliminating intensive wiring, and usage of external & discrete coil-operated functional devices. With such an evolution, Numerical Relays became truly Intelligent Electronic Devices (IED).
- In the previous decade, the direct interface of IEDs to upper level control became possible with monitoring masters like DCS & SCADA on various industrial communication protocols such as Modbus, Profibus, IEC 60870-101/103, etc. IEC 61850 is the recent enhancement under draft review - IEC 62439.

Need for Feeder Protections & Relay

Today, with the increase in loads, voltages and short-circuit function of distribution substation feeders, electrical protection has become more significant. To meet these requirements Numerical Relays are considered to be the right solution, as it comes with the following characteristics-Sensitivity, Selectivity, Speed, Reliability, Repetitive operations and Efficient Communication

About FCOMP

FCOMP is a comprehensive Feeder Control Metering Protection Controller designed for complete feeder protection of air, vacuum or gas-insulated Circuit Breaker-operated Feeders in Medium & Low Voltage Switchgear assemblies.

FCOMP encompasses the ruggedness of conventional feeder protection, versatility of advanced feeder protection features, annunciations and metering in Medium & Low Voltage Switchgear assemblies into one, with a simple-to-configure, compact communicating module with a large color display. It is scalable, modular and right-sized with vertical as well as horizontal orientation with common form factor to cater various feeder protection requirements.

The hardware within FCOMP comes with conformal coating, thereby making it suitable for installation in dusty & corrosive substation environments, which may be present in process industries petrochemical complexes and marine applications. This ensures that FCOMP does not require a conditioned environment as a pre-requisite, and thus can function in any kind of surroundings.

The chapters in this manual are structured in a way to lead a user through various features of the product, and to provide them comprehensive direction for maximizing benefits derived from the efficient usage of the same.

The FCOMP is the output of many engineers in L&T Switchgear who have combined their field experience, application knowledge & learning of integrating various Switchgear mounted IEDs with higher level interface systems such DCS & SCADA PMS in various geographies under some arduous site conditions.

FCOMP Overview

FCOMP comes with the following user-friendly options and features:

- Universal auxiliary power supply
- Industrial operating temperature range
- Monitoring of different electrical parameters
- Current-based metering & protections with optional scalability for Voltage-based metering & protection, in-built into a single unit
- Varied combinations of Digital Inputs & Digital Outputs to reduce the dependency on auxiliary components in different electrical schematics. This enables reduction and simplification of physical wiring in electrical schematics, especially in case of Auto Bus transfer schemes.
- It also allows easier reconfiguration of interlocks, configuration of Load Shedding & Load Sharing, Reverse interlocking, Conditions for Tripping & Closing of Circuit Breaker, Annunciation and Status exchange.
- Configurable pushbuttons for control
- Configurable LEDs for indication
- Conformal coated PCB boards.

FCOMP possesses the following advanced substation communication protocol options:

- Modbus RTU,
- Profibus,
- Modbus TCP/IP,
- IEC 61850

Options for substation IED communication are available through Dual RJ45 and Dual FO (SC or ST) ports for Ethernet communication, and Dual RS485 ports for serial communication. This makes possible up-scaling of substation communication network architecture with redundancy.

Relay is provided with four Setting groups, having multiple stages in each protection settings, wherein a user can select the option of protection source between Fundamental metering and True RMS metering. Also, it comes with one default USB 2.0 front port for easy connection, with a handheld, Laptop or PC.

In addition, Relay comes with its own interface software COMPfigurator to configure the Relay. This software is provided with Configuration settings, Communication settings, Protection settings, Gate logic, Latches, Timers, Event recording and Disturbance recording. It allows online & offline creation of setting files for uploading to & downloading from Relay.

Getting Started

A basic knowledge is required to understand the complete functionality of Relay, which includes its powering-up, and setting date & time for recording of events/trip records. The steps to be followed are shown below-

1. To power-up Relay, check for power supply requirement mentioned on the side label: 85-264@50/60Hz V AC or 110-250 V DC.
2. Check for polarity of power supply as L/+ (Relay terminal A03), N/- (Relay terminal A02) and E (Relay terminal A01) on the Relay rear panel.
3. Once powered-on, the Display glows.
4. After connection, the Display shows logo screen, followed by main screen.
5. Set date and time of Relay from Display Menu or from special commands in COMPfiguratorTM (Refer chapter User Interface).

FCOMP Order Code

Table 2-1: FCOMP Card Selection & Part No. generation

FCOMP PART NO SELECTION OPTIONS																FCOMP PART NO
	PSU	CPU		COMM		IO1		IO2		IO3		VT	CT			
FCOMP	A	B	XXX	X	XXX	1XX	X	2XX	X	3XX	X	XX	C1			FCOMPABXXXXXXX1XXX2XXX3XXXXXC1
Aux Supply	A															85-265VAC@50/60Hz,110-250VDC
Processor Card		B	XXX													1 RS485,Modbus RTU+2DI+2DO
		B	ETH													2 RJ-45,Modbus TCP/IP
		B	FSC													1 FO+SC,Modbus TCP/IP
Communication Card				X	XXX											No card
				P	XXX											1 RS485,Profibus
				X	ETH											2 RJ-45,IEC61850
				X	FSC											2 FO+SC,IEC61850
IO Slots						1XX	X	2XX	X	3XX	X					No Card
						1D2		2D2		3D2						230/110V AC/DC I/P(DIO Card)
							1		1		1					7DI+2DO Form C
							2		2		2					4DI+2DO Form C+3DO Form A
							3		3		3					9DI
							4		4		4					6DI+2DO Form C+1DO Form A
							5		5		5					6DO Form C+1DO Form A
Voltage I/P												XX				No Card
												V1				3 Ph Volt+Vsync,10-132VAC
												V2				3 Ph Volt+Vsync,90-300VAC
Current I/P													C1			1A (R,Y,B,N)+REF
													C2			5 A (R,Y,B,N)+REF
													C3			1A (R,Y,B)+1A CBCT + REF
													C4			5A (R,Y,B)+5A CBCT +REF

Selection of Relay Configuration

Table 2-2: Relay Configuration

	Basic Configuration	Variant options Available
Aux. Power Supply	80-300@50/60Hz V AC or 110-250 V DC	24-48 V DC
Communication	Modbus Serial, Modbus TCP/IP Front Port USB	Profibus IEC 61850 (Ethernet/FO)
Input + Outputs	2 DI + 2 DO	7 DI + 2 DO (Form C) 4 DI + 2 DO (Form C) + 3 DO (Form A) 9 DI 6 DI + 2 DO (Form C) + 1 DO (Form A) 6 DO (Form C) + 1 DO (Form A)
Voltage Input	-	10-132V : R+Y+B+N+Sync 90-300V : R+Y+B+N+Sync
Current Input	Deafult, Selected from available Variants	1A : R+Y+B+N+REF 5A : R+Y+B+N+REF 1A : R+Y+B+SEF+REF 5A : R+Y+B+SEF+REF
Protections	50P, 50N, 50G, 50Q, 51P, 51N, 51G, 51Q, 37, 48, 49, 64	27P, 59P, 59N, 59Q, 81O, 81U, 81R, 25,27S, 59S, 50SG, 51SG, 55, 60, 51V, 32, 32R, 67IP, 67TP, 67IN, 67TN, 67TG, 67IG

Chapter 3

SPECIFICATIONS

General Specifications

Table 3-1: Current Input

Current Input		
In (Nominal Current)	**1 A**	**5 A**
Rated Range	0.1 - 20 A	0.5 - 100.00 A
Continuous Rating	4 A	20 A
1 Second Thermal	100 A	500 A
VA Burden	< 0.05VA	< 0.1 VA
Rated Frequency	50/60 ±5 Hz	50/60 ±5 Hz
Accuracy (10-200% of In)	±1% of reading	±1% of reading
Sensitive Current	**CBCT**	**REF**
Rated Range	0.0025 – 1.6 A	0.02 – 1 A
Continuous Rating	1 A	1 A
1 Second Thermal	100 A	100 A
VA Burden	0.001 VA	0.001 VA
Rated Frequency	50/60 ±5 Hz	50/60 ±5 Hz
Accuracy (10-200% of In)	±1% of reading	±1% of reading

Table 3-2: Voltage Input

Voltage Input		
Voltage level	**110 V**	**230V**
Rated Operating Voltage (Ph-N)	10-132 V AC	90-300 V AC
Rated Continuous Voltage (Ph-N)	110 V AC	240 V AC
10 Second Thermal (Ph-N)	265 V AC	600V AC
VA Burden	< 0.05 VA	< 0.1 VA
Rated Frequency	50/60 ±5 Hz	50/60 ±5 Hz
Accuracy (24-300V)	±1% of reading	±1% of reading

Table 3-3: Auxiliary Supply Input

Auxiliary Supply	
AC Voltage Range	85-264 V AC @ 50/60 Hz
DC Voltage Range	110-250 V DC
Supply voltage fluctuation	±10% of nominal voltage
Supply Voltage Interruption	80 mS
Power Consumption	< 35 VA (AC) < 30 W (DC)
Frequency	
System Frequency	50/60 Hz
Accuracy (40-70 Hz)	±0.01 Hz

Table 3-4: Output Contacts

Digital Outputs		
Heavy Duty Contacts (Default CPU)		
Breaking Capacity	10 A at 250/110 V AC/DC (at L/R = 40 ms) 10 A at 250/110 V AC/DC (at L/R = 20 ms)	
Continuous Current	8 A	
Maximum operate time	15 ms	
Maximum release time	5 ms	
Dielectric strength	4 KV for 1 min	
Rated Insulation Voltage	450 V	
Maximum Operating VA rating	4500 VA	
Normal Contact (Add-On Card)	**Form A (NO)**	**Form C (NO/NC)**
Breaking Capacity	8 A at 250 V AC 5 A at 30 V DC, 0.2 A at 100 V DC	8 A at 250 V AC 5 A at 30 V DC, 0.3 A at 300 V DC
Continuous Current	5 A	5 A
Maximum operate time	10 ms	10 ms
Maximum release time	5 ms	5 ms
Dielectric strength	5 KV	5 KV
Rated Insulation Voltage	300 V	300 V
Maximum Operating VA rating	2000 VA	2000 VA

Table 3-5: Optoisolated Digital Input

Voltage Input		
	CPU Card	**Add-On Card**
220 V AC	ON for 150-265 V AC OFF below 95 V AC	ON for 150-265 V AC OFF below 95 V AC
220 V DC	ON for 176-242 V DC OFF below 132 V DC	ON for 176-242 V DC OFF below 132 V DC
110 V AC	ON for 75-132 V AC OFF below 46 V AC	ON for 75-132 V AC OFF below 46 V AC
110 V DC	ON for 88-121 V DC OFF below 66 V DC	ON for 88-121 V DC OFF below 66 V DC
48 V AC	ON for 38.5-265 V DC OFF below 32 V DC	-
48 V DC	ON for 38.5-265 V DC OFF below 32 V DC	-
Impulse Withstand Voltage	2.5 KV	2.5 KV
Current Drawn	2.2 mA (In case of 110/220V DC) 2.5 mA (In case of 110/220V AC)	1.16 mA (In case of 110/220V DC) 1.50 mA (In case of 110/220V AC)

Table 3-6: Communication Ports

Serial Ports	
Front Panel USB 2.0 port	(Modbus RTU)
Data speed (Baud Rate)	9600, 19200, 38400 bps
RS 485 Rare Port (5 Pin)	(Modbus RTU)
Data speed (Baud Rate)	9600, 19200, 38400 bps
9 Pin D- Connector	Profibus
Data Speed (Baud Rate)	9.6 Kbps – 12 Mbps
Ethernet Ports	
RJ-45 Connectors	Dual 10/100BASE-T copper
Data Speed (Baud Rate)	100 Mbps

Mechanical Specifications

Table 3-7: Enclosure specifications

Dimensions (Horizontal & Vertical Prototype)	
Relay Enclosure (H x W x D)	254mm (10 in.) X 141mm (5.5 in.) X 244mm (9.6 in)
Front collar (H x W x D)	285mm (11.22 in.) X 160mm (6.2 in) X 22mm (0.87 in)
Display (H x W)	62mm (2.44 in) X 108mm (4.25 in)
Weight	
complete Relay	3.8 Kg

Table 3-8: Terminal Connection

Current input connection	
Connecting terminal	Ring Lug Connection
Tightening Torque	1.5 N-m (Max)
Voltage/ Digital input connection	
Connecting terminal	6/10 Pin compression connector
Tightening Torque	1 N-m (Max)

Type Test

Table 3-9: Type Test

Environment Test		
Enclosure Protection	IEC 60529: 2001	IP65 enclosed in panel IP20 for terminals
Shock test	IEC 60255-21-2: 1988	Class 1
Cold test	IEC 60068-2-1: 1990	-40 ^{0}C, 16 hours
Damp Heat, Steady State	IEC 60068-2-78: 2001	40 ^{0}C, 93% relative humidity, 4-days
Temperature Cyclic test	IEC 60068-2-30: 1980	25-55 ^{0}C, 6-cycles, 95% relative humidity
Dry Heat	IEC 60068-2-2: 1993	85^{0}C, 16 hours
Dielectric Strength & Impulse Test		
Dielectric (HIPOT)	IEC 60255-5: 2000,	2.5 kV AC on current inputs 2.0 kV AC on ac voltage inputs, contact I/O 1.0 kV AC on analog output 2.5 kV DC on power supply

Impulse	IEC 60255-5: 2000	0.5 J, 4.7 kV on power supply, contact I/O, ac current and voltage inputs, 0.5 J, 530 V on analog output
RFI & Interference Test		
Electrostatic Discharge Immunity	IEC 61000-4-2: 2001,	Severity Level 4 8 kV contact discharge, 15 kV air discharge
Radiated RF Immunity	IEC 61000-4-3: 2002	10 V/m, 35 V/m
Fast Transient, Burst Immunity	IEC 61000-4-4: 2001	4 kV @ 2.5 kHz (All >40 V and excl.comm) 2 kV @ 5.0 kHz for comm. Ports
Surge Immunity	IEC 61000-4-5: 2001	2 kV line-to-line, 4 kV line-to-earth
Surge Withstand Capability Immunity	IEC 60255-22-1: 1988	2.5 kV common mode, 2.5 kV differential mode 1 kV common mode on comm. Ports 2.5 kV oscillatory, 4 kV fast transient
Conducted RF Immunity	IEC 61000-4-6: 2003,	10 V RMS
Magnetic Field Immunity	IEC 61000-4-8: 2001	1000 A/m for 3 sec, 100 A/m for 1 min
Conducted Emissions	CISPR 22	
Radiated Emissions	CISPR 22	

Environmental Conditions

Table 3-10: Environmental Conditions

Typical conditions under which the Relay is designed to operate	
Temperature	-20 ^{0}C to 70 ^{0}C (Operating) -40 ^{0}C to 85 ^{0}C (Storage)
Relative humidity	5-95%

Certifications

Table 3-11: Certifications

Relay Certificates	
ISO	Relay is designed and manufactured using ISO 9001 certified quality program.
PNO	Profibus DPV0 conformance test certified
UCA	IEC 61850 conformance test certified

Protection Elements

Table 3-12: Current Based Protections specifications

Instantaneous Over Current (50P/50N/50Q/50G)	
Pickup (* In)	0.10 to 20.00 *In (in steps of 0.01* In)
Time Delay	0 to 600 sec (in steps of 0.01 sec)
Timed Over Current (51P/51N/51Q/51G)	
Pickup (PSM) (*In)	0.10 to 3.2 In (in steps of 0.01)
Curve Type	IEEE: Extremely Inverse, Moderately Inverse, Very Inverse IEC: IEC Curve A, IEC Curve B, IEC Curve C
TMS	0.05 to 15.00 (in steps of 0.01 sec)
Thermal Overload (49)	
Pickup (* In)	0.1 to 4 In (in steps of 0.01* In)
Delay	60 to 30000 sec
K-factor	0.1 to 4 (in steps of 0.1)
Pickup Time Accuracy	3% or 75 mA/15 mA 2% class acc. to IEC 60255-8
Timing Accuracy	3% or 1 sec for I/(k·INOM) > 1.25
Phase Under Current (37P)	
Pickup (* In)	0.10 to 3.2 In (in steps of 0.01 In)
Time Delay	0 to 600 sec (in steps of 0.01 sec)
Restricted Earth Fault (64)	
Pickup (* In)	0.02 to 1 In (in steps of 0.01 In)
Time Delay	0 to 1 sec (in steps of 0.01 sec)
Sensitive Ground Fault Instantaneous Over Current (50SG)	
Pickup	0.0025 to 1.6 A (in steps of 0.001)
Time Delay	0 to 600 sec (in steps of 0.01 sec)
Sensitive Ground fault Timed Over Current (51SG)	
Pickup (PSM)	0.0025 to 1.6 A (in steps of 0.001)
TMS	0.05 to 15.00 (in steps of 0.01 sec)
Curve type	IEEE: Extremely Inverse, Moderately Inverse, Very Inverse IEC: IEC Curve A, IEC Curve B, IEC Curve C
Accuracy in all Current Based Protections	
Pickup Accuracy	3% of setting value
Time Accuracy	1.5% of setting value or 30 mSec (whichever is maximum)

Table 3-13: Voltage Based Protections specifications

Under Voltage (27P)	
Pickup	5 V to 1.2 *Vnom
Dropout Level	103% of Pickup
Time Delay	0.01-600 sec (in steps of 0.01 sec)
Blocking Voltage	0 to 75% Vn (in steps of 1%Vn)
Over Voltage (59P)	
Pickup	5 V to 1.2 *Vnom
Dropout Level	97% of Pickup
Time Delay	0.01-600 sec (in steps of 0.01 sec)
Blocking Voltage	0 to 75% (in steps of 1%)
Residual over Voltage (59N)	
Pickup	5 V to 1.2 VNOM
Time Delay	0.01-600 sec (in steps of 0.01 sec)
Sync Supply Under Voltage (27S)	
Pickup Range	0-100% Vn
Time Delay	0-600 Sec
Sync Supply Over Voltage (59S)	
Pickup Range	0-120% Vn
Time Delay	0-600 Sec
Accuracy in all Voltage Based Protections	
Pickup Accuracy	2% of setting value

Table 3-14: Directional Protections specifications

Directional Phase Instantaneous Over Current (67PI)	
Maximum Torque angle/Characteristic angle	-180 to 180 (in steps of 1 deg)
Directionality	Co-existing forward and reverse
Polarisation Voltage Threshold	0 to 1.2 Vn (in steps of 0.01)
Pickup	0.10 In to 20.00 In (in steps of 0.01 A)
Time Delay	0.01-600 sec (in steps of 0.01 sec)
Directional Phase Timed Over Current (67PT)	
Maximum Torque angle/Characteristic angle	-180 to 180 (in steps of 1deg)
Polarisation Voltage Threshold	0 to 1.2 Vn (in steps of 0.01)
Directionality	Co-existing forward and reverse
Pickup	0.10 In to 3.2 In (in steps of 0.01 A)
TMS	0.05- 15.00 (in steps of 0.01)
Curve Type	IEEE: Extremely Inverse, Moderately Inverse, Very Inverse IEC: IEC Curve A, IEC Curve B, IEC Curve C
Directional Neutral Instantaneous Over Current (67NI)	
Maximum Torque angle/Characteristic angle	-90 to 90 (in steps of 1 deg)
Directionality	Co-existing forward and reverse
Polarisation Voltage Threshold	0 to 1.2 Vn (in steps of 0.01)
Pickup	0.10 In to 20.00 In (in steps of 0.01 A)
Time Delay	0.01-600 sec (in steps of 0.01 sec)
Directional Neutral Timed Over Current (67NT)	
Maximum Torque angle/Characteristic angle	-90 to 90 (in steps of 1deg)
Polarisation Voltage Threshold	0 to 1.2 Vn (in steps of 0.01)
Directionality	Co-existing forward and reverse
Pickup (PSM)	0.10 In to 3.2 In (in steps of 0.01 A)
TMS	0.05- 15.00 (in steps of 0.01)
Curve Type	IEEE: Extremely Inverse, Moderately Inverse, Very Inverse IEC: IEC Curve A, IEC Curve B, IEC Curve C
Accuracy in all Directional Based Protections	
Pickup Accuracy	2% of setting value
Time Accuracy	1.5% of setting value or 30 mSec (whichever is maximum)
Angle Accuracy	$\pm 3^0$ electrical

Table 3-15: Power & Frequency Based Protections specifications

Under / Over Power	
Pickup Setting Range, VAR, W Secondary • 5 A models • 1 A models	 1.0-6500.0 VAR, W (in steps of 0.1) 0.2-1300.0 VAR, W (in steps of 0.1)
Overpower Drop-off	0.95 x setting ±10%
Underpower Drop-off	1.05 x setting ±10%
Time Delay	0.00 to 600 sec (in steps of 0.01 sec)
Reverse Power	
Pickup Setting Range, VAR, W Secondary • 5 A models • 1 A models	 1.0 - 6500.0 VAR, W (in steps of 0.1) 0.2 - 1300.0 VAR, W (in steps of 0.1)
Time Delay	0 to 600 sec (in steps of 0.01 sec)
Power Factor	
Lead/Lag PF Pickup Range	0.05 to 0.95
Lead/Lag PF Trip Delay	1 to 240 sec
Under / Over Frequency	
Pickup	20.00 to 70.00 Hz (in steps of 0.01)
Time Delay	0.01 to 100 sec (in steps of 0.01)
Minimum Signal	0.6 to 1.25 Vn or 60 V, which is minimum (in steps of 0.01)
Pickup Accuracy	±0.01 Hz
Dropout Level	Pickup ± 0.03 Hz
Frequency Gradient	
Pickup	0.01 to 20.00 Hz/Sec
Time Delay	0.00 to 100.00 Sec
Min/Max frequency range	20.00 to 70.00 Hz
Pickup Accuracy	±0.01 Hz/Sec

Table 3-16: Ancillary Protections specifications

Synchrocheck (25)	
Voltage Difference	0 to 150 V
Angle difference	0 to 120 deg
Frequency difference	0 to 3 Hz

Cold Load Pickup	
Open Delay	0 to 1500 sec (in steps of 0.01)
Active Delay	10 to 15000 sec (in steps of 0.01)
Second Harmonic Blocking	
Pickup	10% to 70%
Breaker Failure	
DI requirement (Yes/No)	No
DI selection	0 to 30
Auto-Reclosure	
No. Of shots	1 to 4
Dead Time	0.1 to 100 sec
Reclaim time	0.1 to 100 sec
CT Supervision	
Threshold setting (* In)	0 -1.00
Inhibit setting (* In)	0 -1.00
Time delay	0 - 500 sec
VT Supervision	
Function Enable/Disable	

Metering & Monitoring

Table 3-17: Metering specifications

Currents	
Range	0.1 to 20 INOM
Phase Currents	±1% Accuracy
Neutral & REF current (using CBCT)	±1% Accuracy
Sequence Components	±1% Accuracy
Voltages	
Range	5 to 300V
L-L & L-N Voltages	±1% Accuracy
Sequence Components	±1% Accuracy
Frequency	
Range	20 to 70 Hz with ±1% Accuracy
Power	
3 Phase Real Power (kW)	±2% Accuracy
3 Phase Reactive Power (kVAR)	±2% Accuracy
3 Phase Apparent Power (kVA)	±2% Accuracy
Power Factor	
Range	Lead/Lag measurement with ±2% Accuracy
Energy	
3 Phase Real Energy (kWh)	±2% Accuracy
3 Phase Reactive Energy (kVARh)	±2% Accuracy
3 Phase Apparent Energy (kVAh)	±2% Accuracy

Table 3-18: Data Recording

Event Log	
Event information	Event Cause, Event Date -Time stamping
Capacity 1024	Event Records
Time-tag (Resolution)	1 msec
Oscillography	
Sampling Rate	16 (128 Cycles) / 32 (64 Cycles) / 64 (32 Cycles)
Maximum Records	64
Data (User Configurable)	AC input channels, Protection state, DI/ DO Status

Processing

Table 3-19: Processing

Processing	
AC Voltage and Current Inputs	64 samples per power system cycle
Frequency Tracking Range	20 to 70 Hz
Protection & Control Processing	3 times per power system cycle (every 6 mSec) Analog quantity processing is in every 100 msec. Selectable filtering for protection base (Fundamental or True RMS)

Chapter 4

INSTALLATION

Overview

This section provides information about the installation of Relay and various connections attached to its ports. Prior to installation and connection of Relay, the user must be familiar with its configurations and features, for its safe functioning.

The section describes about the Mechanical Installation of Relay, along with the dimensions and product labels. These dimensions help in identifying proper installation space for Relay and its wiring connections.

Mechanical Installations

This section provides description about the Mechanical Installation of the both horizontal as well as vertically oriented Relays. These dimensions help in identifying proper installation space for the Relay and its wiring connections. Figure 4–1 and figure 4-2 shows the dimension diagram of the vertical Relay and horizontal relay.

Dimensions

Figure 4–1 and figure 4-2 shows the dimension diagram of the vertical Relay and horizontal relay.

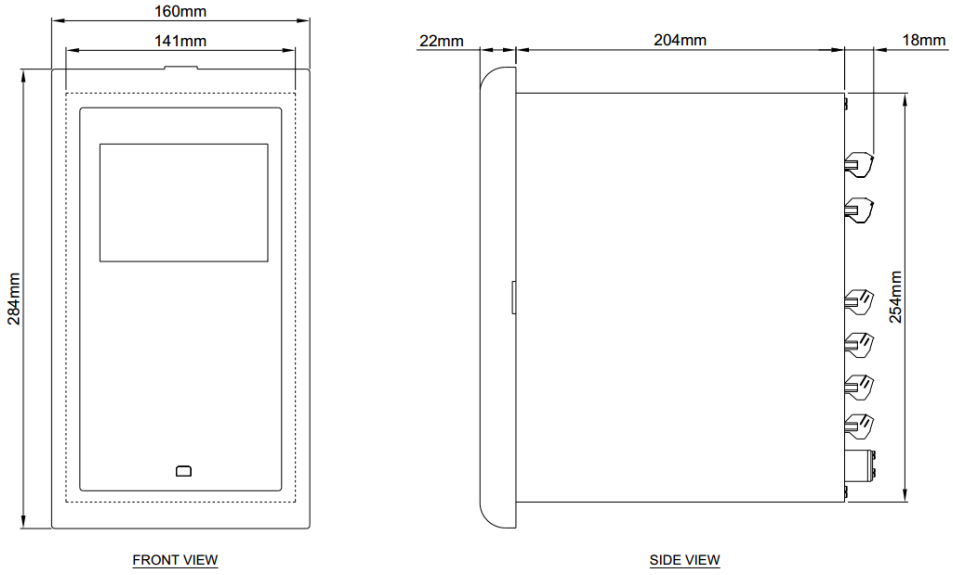


Figure 4-1: Vertical Relay Dimension

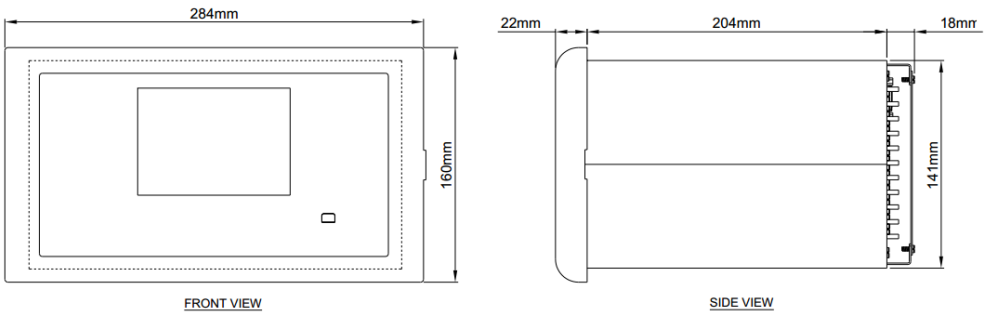


Figure 4-2: Horizontal Relay Dimensions

Mounting

The Relay is mounted in a cut-out on the front of the panel and fixed by using mounting screws. Figure 4–3 and figure 4-4 shows the Relay installation for both the form factor.

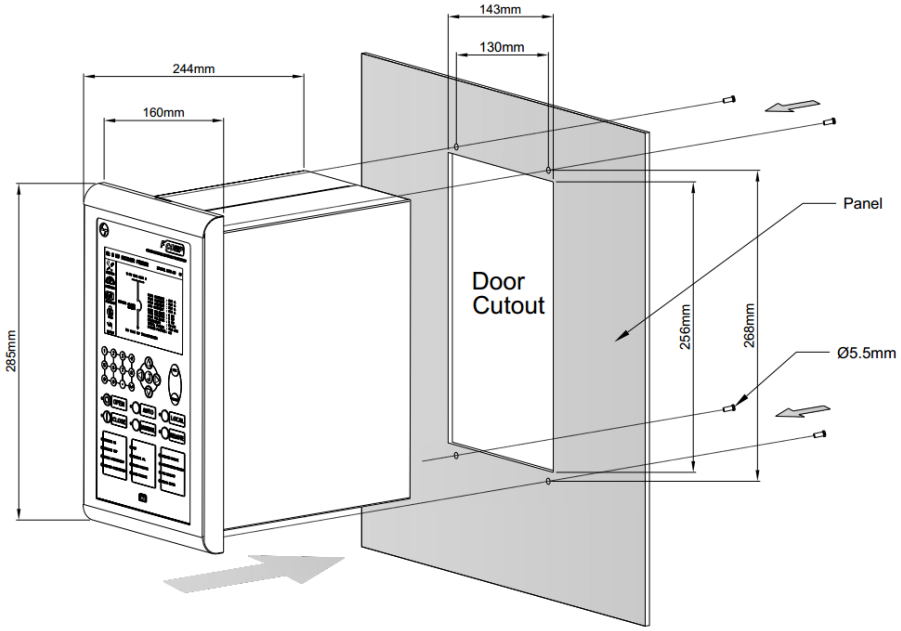


Figure 4-3: Vertical Relay Installation

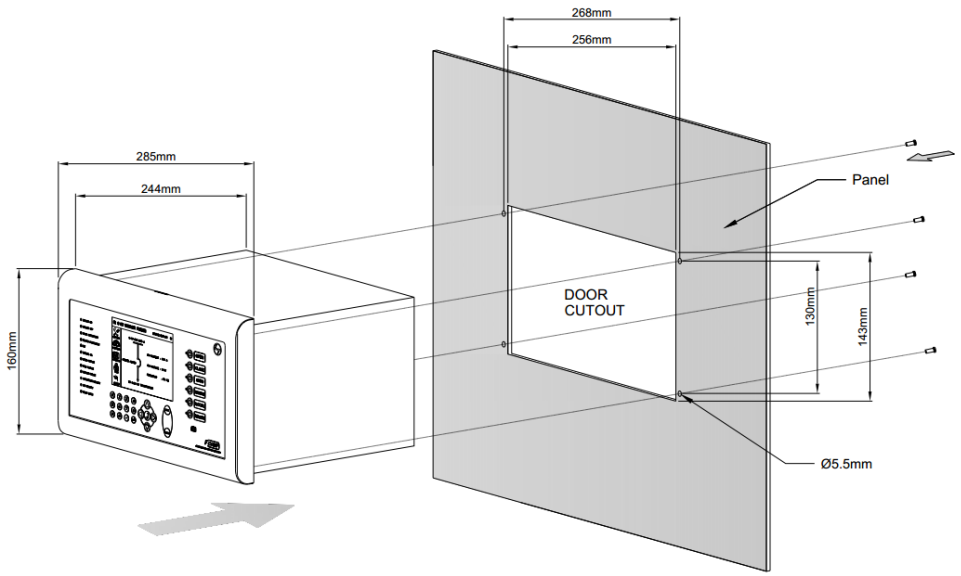


Figure 4-4: Horizontal Relay Installation

Procedure to mount the Relay in panel:

- Ensure that Relay is free from all rear connections.
- Insert Relay from front of the panel cut-out.
- Hold Relay in alignment with the mounting holes.
- Fix Relay with panel with four mounting screws from rear.

Procedure to un-mount relay from panel

- Ensure that Relay is free from all rear connections.
- Loosen the four mounting screws.
- Detach Relay from the panel.

Electrical Installations

This section describes complete electrical wiring of the relay with connectors' arrangement for Current input, voltage input, and digital input termination.

Relay Wiring

Figure 4–5 shows the overview of the Relay wiring with the electrical system.

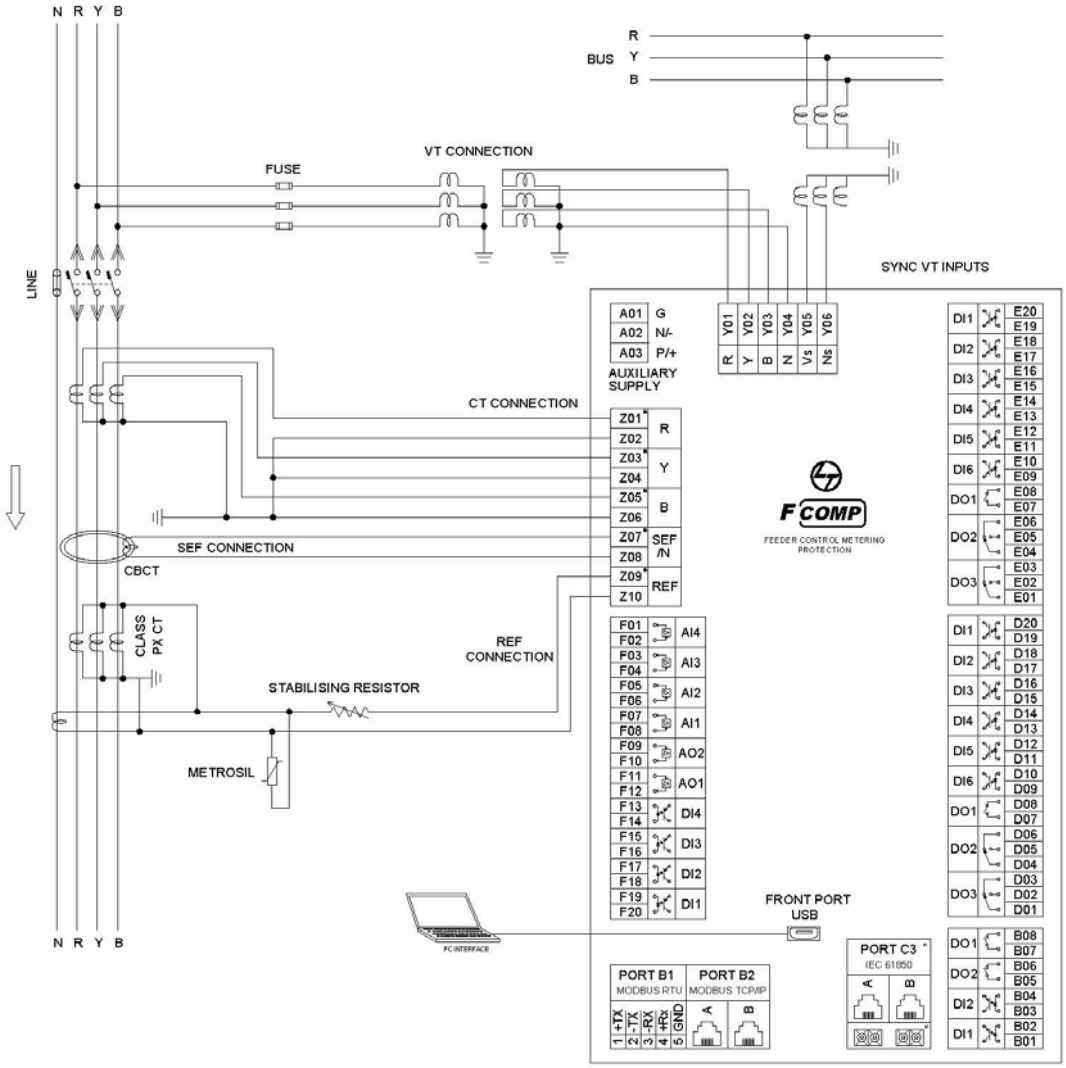


Figure 4-5: Typical wiring Diagram

Rear Panel Connections

Figure 4-6 shows the rear panel connection of the relay.

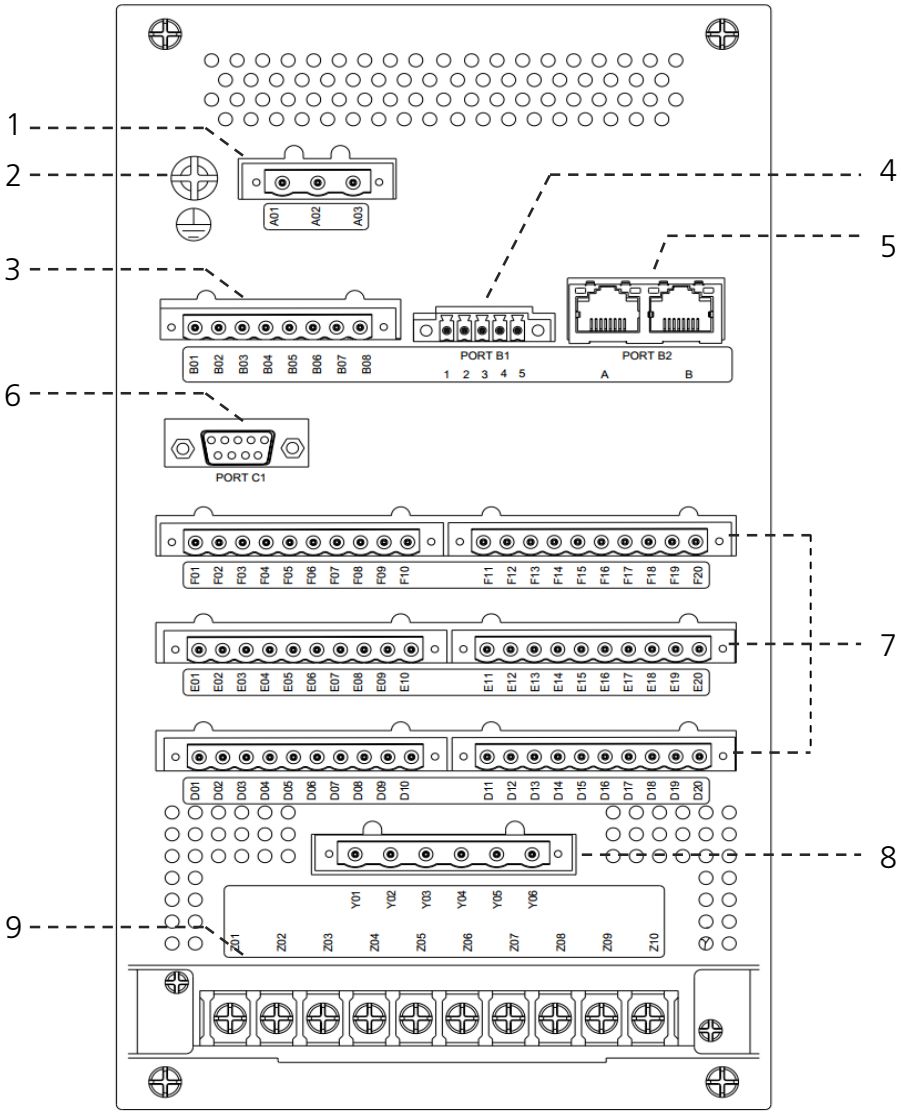


Figure 4-6: Rear Panel Connection

1	Power supply connector
2	Earthing
3	Basic DIO connector
4	Modbus RTU connector
5 M	odbus TCPIP port

6	Profibus Port
7	Add-On DIO connector
8	VT Connector
9	CT Connector

Auxiliary Supply connection

To power up Relay, auxiliary power supply is a requisite. Universal power supply ranging from 85 to 265 V AC @ 50/60 Hz or 110V-250 V DC is employed as an auxiliary supply. Over Current, Over Voltage and Under Voltage protection are provided through power supply input card.

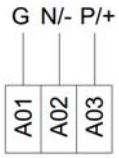


Figure 4-7: Auxiliary supply Connection

Procedure to wire the auxiliary supply connector:

- Check the connector cable for proper operation.
- Loosen the terminal screws.
- Insert the supply wires in their respective terminals. Make note of the power supply rating of Relay before inserting the supply wires in.
- Tighten the terminal screws.
- Anchor the auxiliary supply connector by using two connector screws.

Procedure for removal of the connector:

- Ensure that Relay is free from all possible power connections.
- Loosen the two connector screws.
- Remove the auxiliary supply connector from Relay.

3-Phase Voltage Connection

With the voltage inputs option, the AC voltages may be directly connected, or by WYE-WYE VT or open-delta VT can be used.

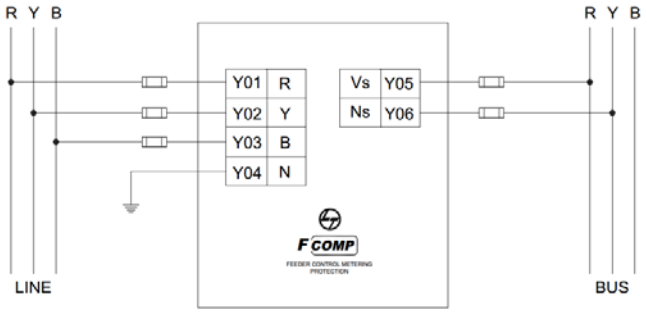


Figure 4-8: Direct Voltage Input Connection

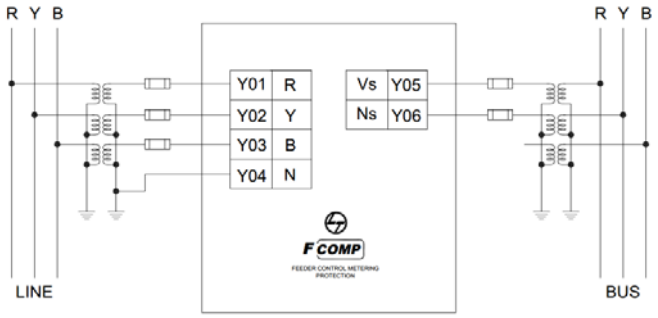


Figure 4-9: Voltage Input Connection with Y-Y external VT

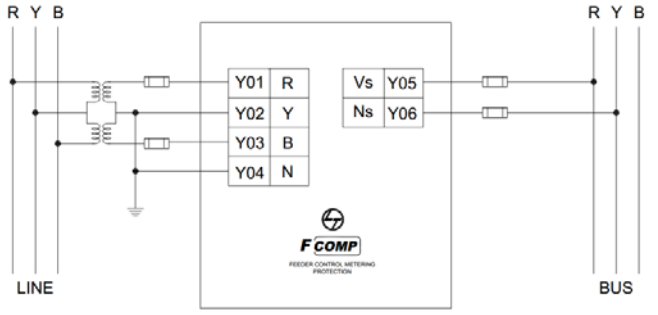


Figure 4-10: Voltage Input Connection with Open delta VT

Procedure to wire the voltage connector:

- Ensure that Relay is free from all power connections.
- Check the connector cable for proper operation.
- Loosen terminal screws of the connector.
- Insert the RYB wires in their respective terminals.
- Tighten the terminal screws.
- Anchor the connector by using two connector screws.

Procedure for removal of the voltage connector:

- Ensure that the Relay is free from all power connections.
- Loosen the two connector screws.
- Detach the connector from the Relay.

3-Phase Current Connections

The connection to the Relay current input port is shown in Figure 4–11 with CBCT and other safety accessories.

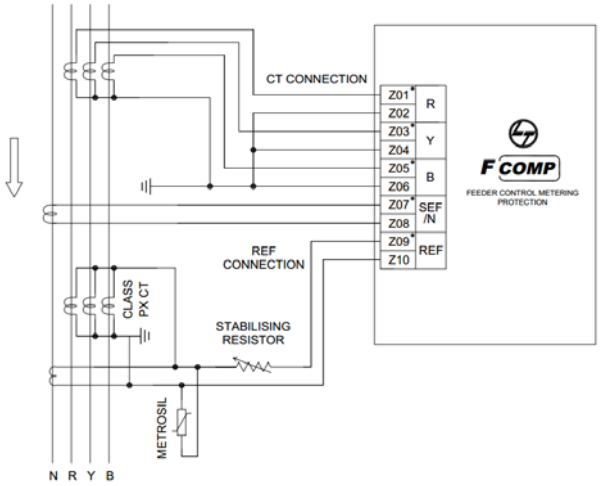


Figure 4-11: 3-phase CT Connection with Neutral CT

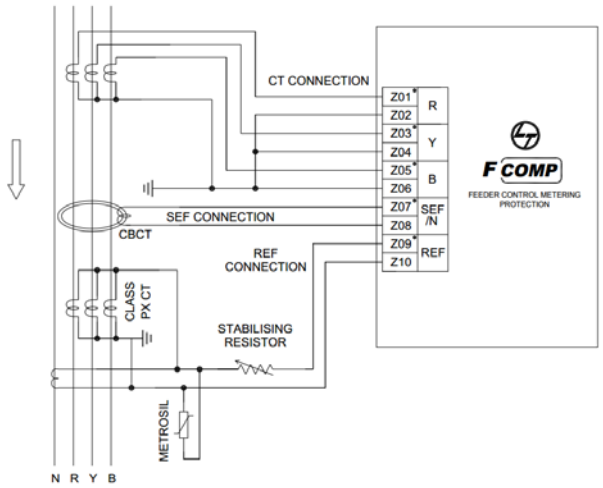


Figure 4-12: 3-phase CT Connection with CBCT

Procedure to wire the current connector:

- Ensure that the Relay is free from all power connections.
- Insert the RYB wires in their respective terminals (use fork lugs for more safety).
- Tighten the terminal screws.

Procedure for removal of the current connector:

- Ensure that the Relay is free from all power connections.
- Loosen the two connector screws.
- Detach RYB cables from the Relay.

DIO Connection

Relay has two Digital Inputs and two heavy-duty Digital output contacts as basic configuration within its Processor card. Relay has three card slots for optional DIO inputs. Mentioned below are the card options in each slot:

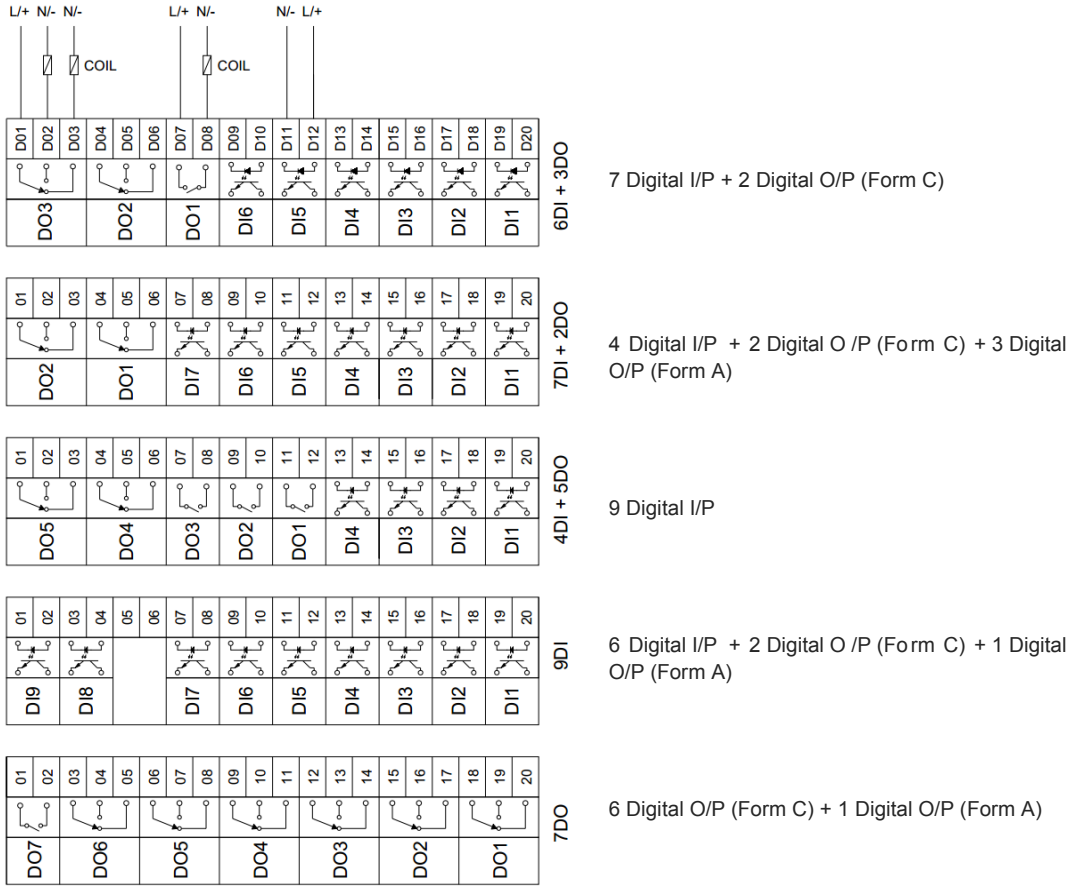


Figure 4-13: Digital Input/output connection and variant

The two types of digital output contacts are as mentioned below:

- **Normally open**: It is the two-point contact (NO, C - FORM A), which is generally open, and is closed when activated.
- **Changeover:** It is three-point contact (NO, C, NC - FORM C), which changes its state from NO to NC, from and NC to NO when activated.

These outputs can be programmed to any of the output functions like trip, alarm, latch, command, annunciation, etc.

Procedure to wire the connector:

- Check the connector cable for proper operation.
- Loosen the terminal screws.
- Insert the wires in their respective terminals. Tighten the terminal screws.
- Anchor the DIO connector cable by using two connector screws.

Procedure for removal of the connector:

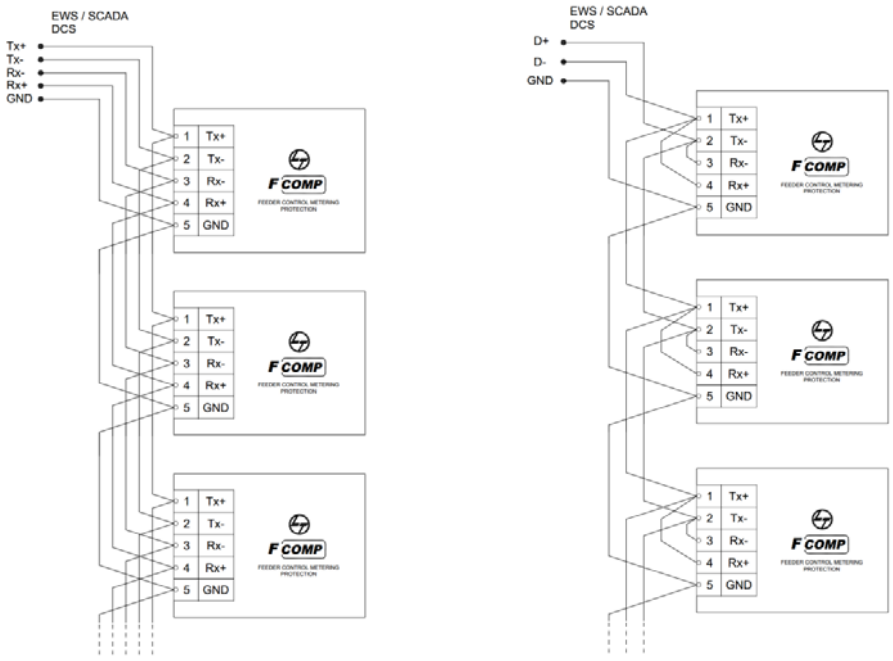
- Make sure that the Relay is free from all the power connections.
- Loosen the two connector screws.
- Detach DIO connector from the Relay.

Communication Port Connections

RS485, RJ45 and FO ports are available for communication. These ports are used to communicate with the upper level systems such as EWS/DCS/SCADA on either Modbus RTU/Profibus/Modbus TCP/IP/IEC 61850 protocols. Figure 4–13 to Figure 4–17 show the communication connection with looping diagrams.

RS 485 Port for Modbus RTU

RS485 can address up to 32 slaves using either a two wire (half duplex) or four wire system (full duplex) and has a distance capacity of 4000 m.



4 Wired Communication 2 Wired communication

Figure 4-14: Modbus RTU Connection with RS485 Port

RJ45 Port for Modbus TCP/IP

The IP address of each device in a Modbus TCP/IP communication should be different from other.

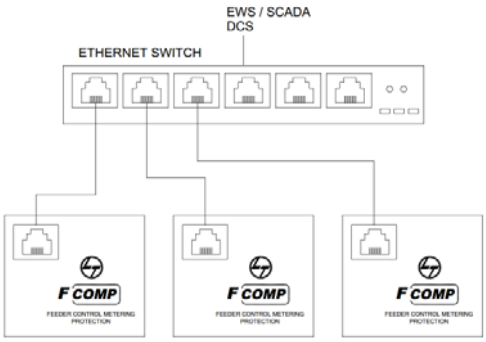


Figure 4-15: Modbus TCP/IP connection with RJ45 port

RS 485 Port for Profibus

Figure 4-16 shows the connection for profibus communication. Each device should have different Node address.

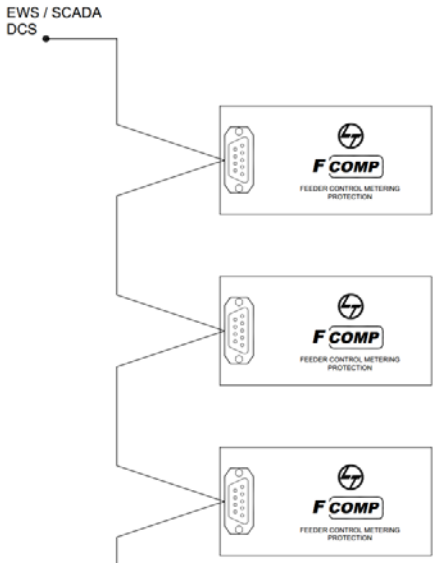


Figure 4-16: Profibus connection with D-connector

Labels and Terminal Numbers

Relay comprises multiple optional units. The user can choose a unit, depending on the application while ordering for Relay. Figure 4–20 shows example of the optional units generally used in the Relay. Marking on the label represents that selected variant card is available in the ordered relay.

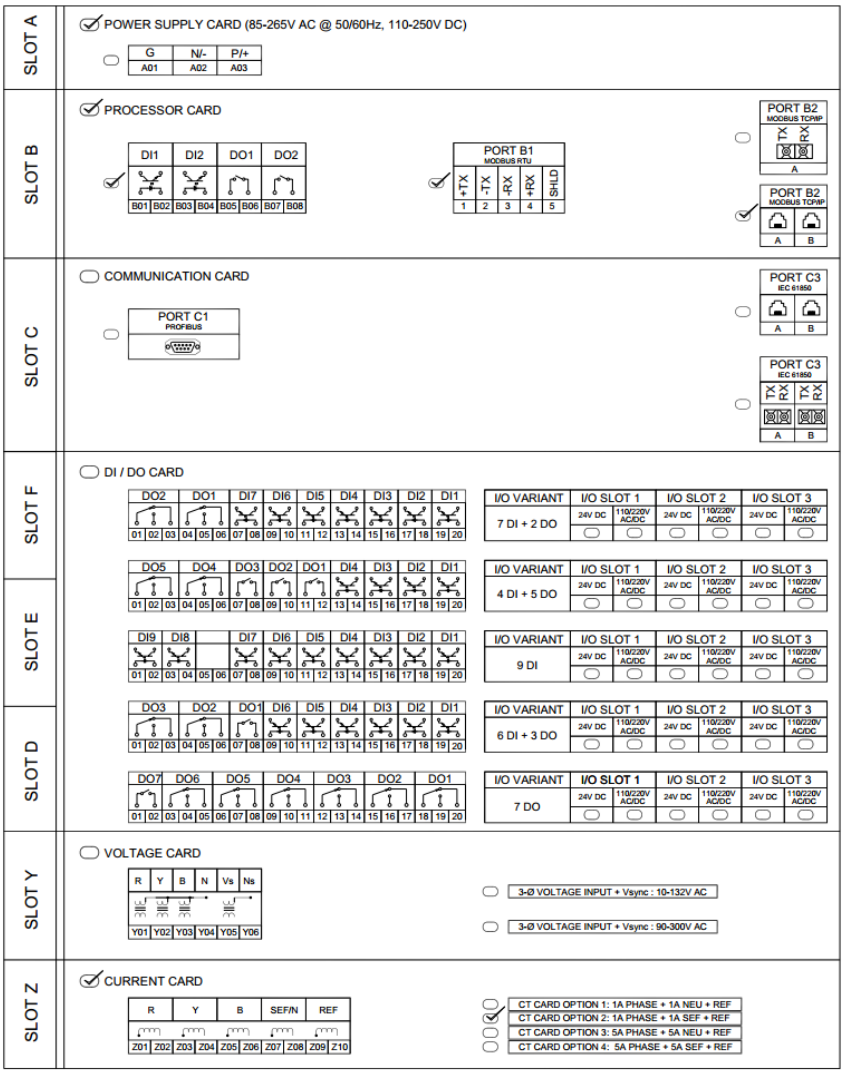


Figure 4-16: Labels and Terminal Numbers

Chapter 5

Metering & Monitoring

Overview

Relay includes metering functions to display the real time values of current, voltage, and other electrical parameters as well as digital input & output status. Relay takes 64 samples per cycle for measurement of RMS current and RMS voltage parameters.

Metering & monitoring can be done local as well as remotely through

- Front Panel Display
- COMPfigurator™ Software
- SCADA/DCS

Metering

Relay is able to measure the following quantities -

- True RMS Values of Current & Voltages
- Fundamental and 3 phase Average of Current & Voltages
- Maximum values of currents & voltages
- Positive, Negative, Zero Sequence Components of current & Voltage
- Active, Reactive, Apparent Power & Energy
- Power factor & System Frequency
- Harmonic Distortion (Upto 25th Harmonics)
- Demand Metering (Current & Power)

Current Metering

Line Current

Relay measures magnitudes (in Amps) and angles (in deg) of R, Y, B Phase currents. R phase current Phasor is considered as a reference for angle measurement if voltage card present in relay else R phase voltage phasor is considered as reference.

I_R : Current flowing through R phase

I_Y : Current flowing through Y phase

I_B : Current flowing through B phase

Ground Current

Ground current IG is the earth leakage current in case of 3 phases 4 Wire system calculated by vector sum of 3 phase currents:

$$\bar{I_G} = \bar{I_R} + \bar{I_Y} + \bar{I_B}$$

Neutral Current

Neutral current IN is the earth leakage current in case of 3 phase 4 Wire systems (Star Connection) measured with neutral/Residual CT connection.

SEF Current

CBCT (Core Balance Current Transformer) is applied for Earth leakage measurement in sensitive Earth Fault conditions. The 3-phase supply passes through CBCT, which senses the Earth Fault current under abnormal conditions.

REF Current

REF Current is differential Earth leakage current measured in a defined region with REF CT. It is used to sense internal fault of transformer. In scheme with REF protection, common terminal of the phase currents is connected to secondary of the neutral CT such that secondary unbalance of phase currents opposes secondary of Neutral CT. In no fault condition, REF current is ideally equal to zero

Average Current

Average Current (Iavg) is a average of the magnitude of the currents in all three phases calculated as:

$$I_{AVG} = \frac{I_R + I_Y + I_B}{3}$$

Fundamental Current

True RMS currents of all phases consist of disturbance in fundamental pure sine waveform due to harmonics. Relay provides fundamental metering at fundamental frequency (50/60 Hz) for all three phase & Neutral currents with ease to calculate the distortion in the system.

Maximum Current

It measures and stores the maximum current of each phase, whenever peak occurs in the system. It replaces and updates the value with every peak instance recorded by the relay.

CTs used for measurement (5 CTs): Rph + Yph + Bph + N/SEF + REF

Measurement Accuracy = ±1% with resolution 0.001A

Note: *Current measurements are displayed in amperes in accordance with Current Ratio.*

Voltage Metering

Ph-N and Ph-Ph Voltages

Relay measures magnitudes (in Volts) and angles (in deg) of R, Y, B Phase to neutral Voltages as well as Phase to Phase voltages.

V_R : R phase voltage with respect to neutral

V_Y : Y phase voltage with respect to neutral

V_B : B phase voltage with respect to neutral

V_{RY} : R and Y Phase to Phase Voltage

V_{YB} : Y and B Phase to Phase Voltage

V_{BR} : B and R Phase to Phase Voltage

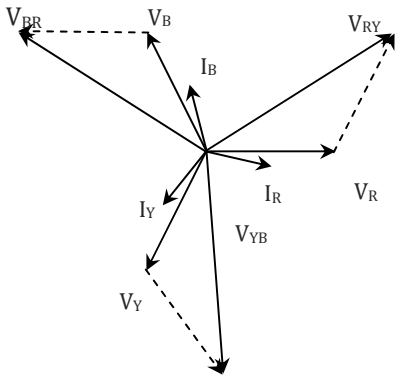


Figure 5-1: Phasor Diagram

Average Voltage

It is an average of the magnitude of the Phase to neutral voltages in all three phases calculated as:

$$V_{AVG} = \frac{V_R + V_Y + V_B}{3}$$

Residual Voltage

Residual Voltage indicates the neutral point voltage with respect to earth & is equal to the vector sum of the Phase to neutral voltages in all three phases. Residual voltage protection is provided in case of open delta connection (Neutral Displacement)

$$\overline{V_N} = \overline{V_R} + \overline{V_Y} + \overline{V_B}$$

Sync Voltage

It is the phase to phase or phase to neutral voltage tapped from Second source or bus, to check synchronism between two voltage sources. A connection with two pins is provided for measurement where potential difference between two phases is calculated. Angle is measured with respect to R Phase voltage of Line 1.

Fundamental Voltage

True RMS voltages of all phases consist of distortion in fundamental pure sine waveform due to harmonics. Relay provides fundamental metering at fundamental frequency (50/60 Hz) for all three phase & Neutral voltages as well as Phase to Phase voltages with ease to calculate the distortion in the system.

Maximum Voltage

It measures and stores the maximum voltage of each phase, whenever peak occurs in the system. It replaces and updates the value with every peak instance recorded by the relay.

Phase Sequence

Relay detects the presence of each phase and checks in which sequence / roatation phases are connected i.e. RYB or RBY. It declares phase loss in case voltage is not detected in any of the phase.

Voltage Unbalance:

The unbalance due to harmonics or due to sags, swells, over-voltages, under-voltages, impulses, transients, surges and interruptions (outages) is calculated with respect to balanced system.

Voltage inputs for measurement (6 No.): R + Y + B + N + Sync 1 + Sync 2

Measurement Accuracy = ±1% with resolution 0.001A

Note: *All Voltage measurements are displayed in volts in accordance with Voltage Ratio and star delta setting.*

Symmetrical Components

The electrical power system normally operates in a balanced 3-phase sinusoidal steady-state mode. However, there are certain fault situations that can cause unbalanced operations. By the method of symmetrical co-ordinates, a set of unbalanced voltages (or currents) may be resolved into systems of balanced voltages (or currents) equal in number to the number of phases involved. These sequence components are known as Positive, Negative and Zero sequence components.

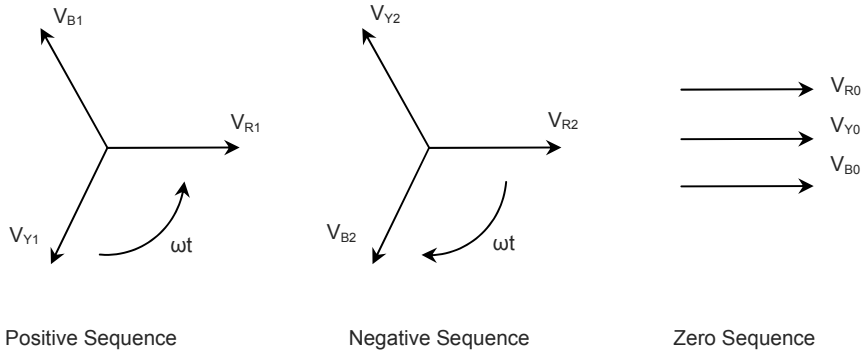


Figure 5-2: Symmetrical components during fault condition

All the sequential components can be calculated as follow.

Voltage components

$$\begin{bmatrix} V_0 \\ V_1 \\ V_2 \end{bmatrix} = 1/3 \text{ X} \begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha \end{bmatrix} \begin{bmatrix} V_R \\ V_Y \\ V_B \end{bmatrix}$$

Where V_0 : Zero sequence Voltage

V_1 : Positive Sequence Voltage

V_2 : Negative Sequence Voltage

Current components

$$\begin{bmatrix} I_0 \\ I_1 \\ I_2 \end{bmatrix} = 1/3 \text{ X} \begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha \end{bmatrix} \begin{bmatrix} I_R \\ I_Y \\ I_B \end{bmatrix}$$

Where I_0 : Zero sequence Current

I_1 : Positive Sequence Current

I_2 : Negative Sequence Current; $\alpha = 1 \angle 120^0$

Harmonics Distortion

Relay analyses the distortion of waveform of an electrical parameters due to harmonics. Harmonics are current or voltage components in an electrical system due to non-linear loads such as rectifiers, transformers, Inductive loads, variable speed drives etc. Current harmonics have an effect on the electrical distribution equipment, causes increase in heating of the equipment. Voltage harmonics arise when current harmonics are able to create sags in the voltage supply. The amount of sag depends on many factors like transformer impedance, wire size, etc. The magnitude of the voltage harmonics depend on the stiffness of the electrical distribution system impedance.

For example, considering system of 50Hz, In ideal system current & voltages have pure sine wave with only fundamental frequency 50Hz, But in practical case as none of the system is ideal, It consists frequency components which are integral multiple of the fundamental (2f =100Hz, 3f =150Hz, 4f= 200Hz……nf= n*50Hz). Thus, harmonic distortion is the degree to which a wave form deviates from

its pure sinusoidal values as a result of the summation of all harmonic elements. The distortion due to nth harmonic frequency is calculated w.r.t. fundamental frequency as

$$\text{Nth Harmonic Distortion}(\%) = \frac{\text{Nth Harmonic Component}}{\text{Fundamental Component}} \text{X}100$$

Figure 5-4 elaborates the different components due to harmonics.

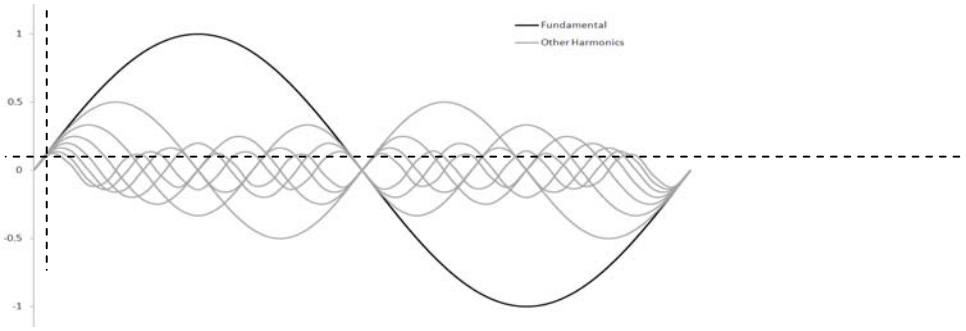


Figure 5-3: Different Harmonics in voltage /current Waveform

Figure 5-5 explains how the pure sine wave is distorted due to 4th harmonic component.

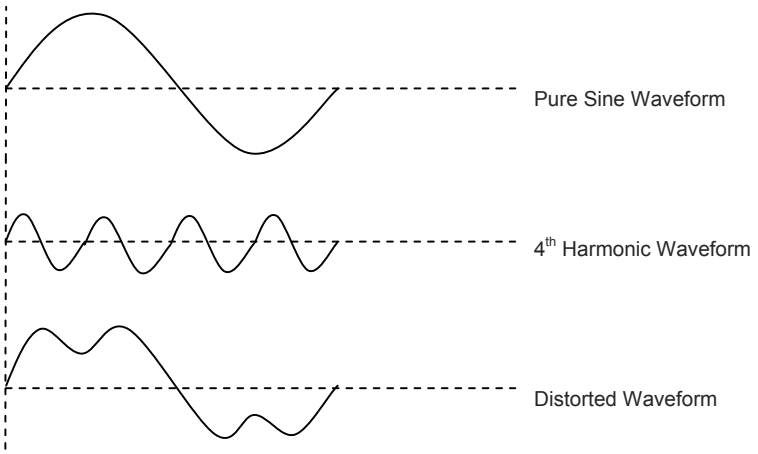


Figure 5-4: Effect of Harmonic on voltage /current Waveform

Total Harmonic Distortion

Total harmonic distortion (THD) is the summation of all harmonic components of the voltage or current waveform compared to the fundamental component of the voltage or current wave as shown in Figure 5–5 and is calculated using the following formulae.

$$\text{Voltage THD} = \frac{\sqrt{(V_2{}^2 + V_3{}^2 + V_4{}^2 + \ldots\ldots + V_n{}^2)}}{V_1} \text{ X } 100$$

Where V1 = Fundamental harmonic of voltage

V2, V3, ……., Vn = other voltage harmonic components

$$\text{Current THD} = \frac{\sqrt{(I_2{}^2 + I_3{}^2 + I_4{}^2 + \ldots\ldots + I_n{}^2)}}{I_1} \text{X } 100$$

Where I1 = Fundamental harmonic of current

I2, I3, ……., In = Other current harmonic components

Frequency Metering

Relay measures the frequency of 3-phase supply voltage. Frequency is the total number of cycles per unit time. Frequency is measured in number of cycles per second. The relationship between frequency and time is given by

$$f = \frac{1}{T}$$

Demand Metering

Demand (kW) is the optimum amount of energy required by the consumer in specific interval of time. Demand metering is the measurement of average power requirements during a certain predefined time interval. Demand billing consists of measuring a customer's maximum average load during any demand interval of the billing period.

Demand calculation can be done by the following methods:

Block demand (with optional sub-intervals)

Maximum demand is based on the highest average demand during any one demand interval. The interval length shall be set by the user from 1-60 minutes in 1 minute intervals. The user shall be able to set the sub-interval length from 1-60 minutes in 1-minute intervals. The following Block methods are available:

- Sliding Block that calculates demand in every 15 seconds with intervals less than 15 minutes, and every 60 seconds with an interval between 15 and 60 minutes.
- Fixed Block that calculates demand at the end of the interval.

Rolling demand

The calculation of rolling demand allows the interval used for calculating demand to be subdivided into even subintervals to determine the maximum or minimum interval. Rolling demand will always be equal or greater than Block demand. The advantage of employing this method is that it accurately measures the true peak. Maximum demand is based on the highest three consecutive demand subintervals.

Power & Energy Metering

FCOMP Relay uses the IEEE convention for power measurement. The implications of this convention are depicted in Figure 5–2.

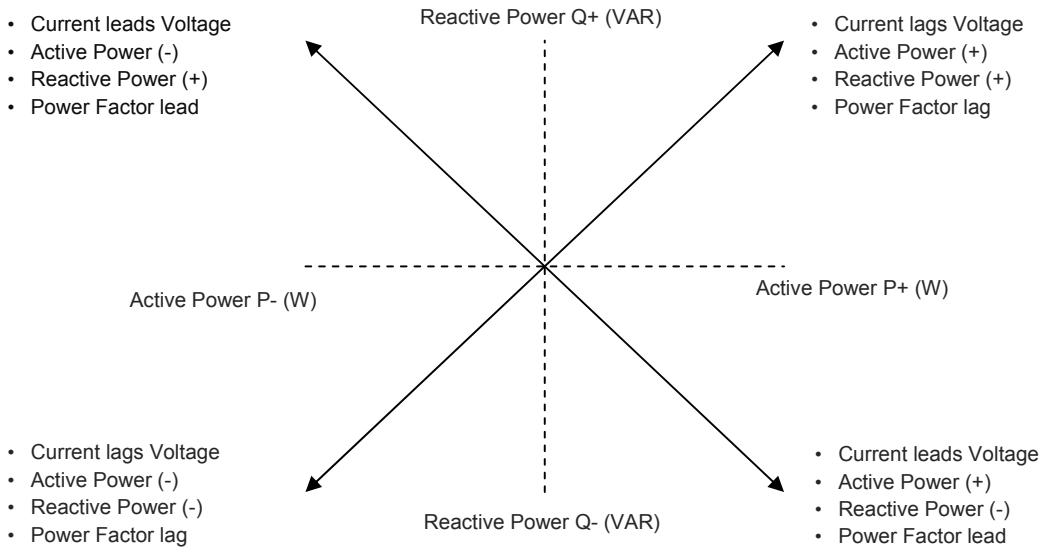


Figure 5-5: Four quadrant Power Operation

Power

Active power is also known as real power, which gives the information about the load on any of the electrical system at that instant of time. It is calculated using the following formulae:

Active Power in R-Phase (W) = V_R x I_R x cos ⍰

Active Power in Y-Phase (W) = V_Y x I_Y x cos ⍰

Active Power in B-Phase (W) = V_B x I_B x cos ⍰

Total Active Power (W)=(V_R x I_R x cos ⍰) + (V_Y x I_Y x cos ⍰) + (V_B x I_B x cos ⍰)

Reactive Power is required by inductive loads caused due to magnetizing current component. It is calculated using the following formulae:

Reactive Power in R-Phase (VAR) = V_R x I_R x sin ⍰

Reactive Power in Y-Phase (VAR) = V_Y x I_Y x sin ⍰

Reactive Power in B-Phase (VAR) = V_B x I_B x sin ⍰

Total Reactive Power (VAR) = (V_R x I_R x sin ⍰) + (V_Y x I_Y x sin ⍰) + (V_B x I_B x sin ⍰⍰)

Apparent power is total power utilized by the electrical system.

$$\text{Total Apparent power (VA)} = (V_R \times I_R) + (V_Y \times I_Y) + (V_B \times I_B)$$

It also calculates maximum active reactive as well as apparent power drawn by the system when peak demand is recorded in system.

Measurement Accuracy = ±2% with resolution 0.001KW/KVAR/KVA

Energy

Total Energy consumed by the load is measured using the following formulae:

Total Active Energy (Wh) = Total Active Power x No. of hours run

Total Reactive Energy (VARh) = Total Reactive Power x No. of hours run

Total Apparent Energy (VAh) = Total Apparent Power x No. of hours run

Measurement Accuracy = ±2% with resolution 0.001 KWh/KVARh/KVAh

Power Factor

Power factor is the cosine of the angle between the phase currents and phase voltages. It can also be represented as the absolute value of the ratio of Active Power to Apparent Power.

Power factor is calculated using the below-mentioned formulae:

$$\text{Power Factor } (\cos) = \frac{\text{Total Active Power}}{\text{Total Apparent Power}}$$

Where is phase angle between current & voltage phasors

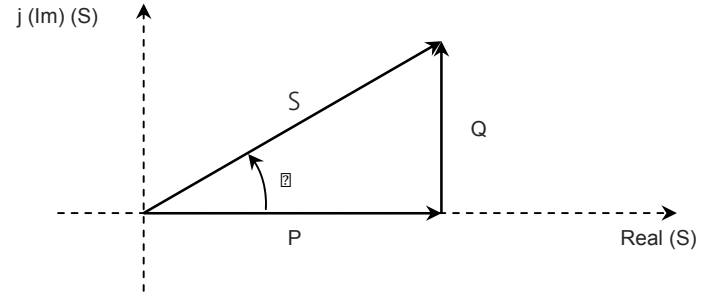


Figure 5-6: Power Triangle

Measurement Accuracy = ±2% with resolution 0.01

Hour Meter

It measures from how much time in hours the feeder is in operation i.e relay is protecting the feeder. The time can be displayed up to 7 digits.

DIO Status

Relay provides ON/OFF status for all digital inputs & Close/ Open status for all digital Outputs of default DIDO's available in basic relay as well as add-on card DIDO's.

Monitoring

Relay is able to monitor following data

- Event Log
- Oscillography
- Data Recorder
- Self-Diagnostics
- Phasor Diagram

Event Log

Relay can also generate sequence of events based on their individual protection elements and digital, analog or contact inputs. It can be programmed to recognize and record events and alarms. Triggering of the recording function within the Relay is programmable and based on the internal measuring elements within the device.

Its function is to gather operational data from substation equipment (for example, Relays, circuit breakers, transformers), control schemes (manual and automatic) as they react to a system event, along with date and time. This series of sequential, individual events can be from a switching operation, fault, or disoperation and can be contained within a single substation, a line & associated substations, a utility system, or several interconnected systems. This data allows the chain of events to be studied for the cause (or causes) of the disoperation and the linkages between individual actions & effects. Time tagging can be synchronised with the use of Global Positioning System (GPS) and Universal Time Code (UTC).

Table 5-1: Event Log Characteristics

Event Information	
Trigger Points (Configurable)	Pickup / Dropout Alarm / Trip / Trip Reset Digital input change of state Digital output change of state Self-test events
Data Parameters	Event Cause Event Date and time Status of 8 User Selectable Parameters
Time tag(Resolution)	1 msec

Oscillography

Oscillography records contain waveforms captured at the predefined sampling rate as well as other preset Relay data at the point of trigger. For example, fault triggered in R-phase due to over current is shown in Figure 5–9. The purpose of this record is to provide a general understanding of the occurred fault and related errors due to the characteristics of analog or digital inputs to carry out a cause analysis of the fault. In addition, the required inputs necessary to effectively capture a power system event can be programmed.

Typical four types of disturbances that can be categorised by the fault/event duration are as follows:.

- Transient: These are very short in duration and include faults that are cleared immediately by circuit breaker operation. These events are generally no longer than 8 cycles for high-speed clearing, and 16 cycles for sequential line clearing. These events are usually analysed to determine correct protection operation, fault location, or verification of system model parameters.
- Short Term: These generally include all other time-delayed fault clearing and reclosing events where the system operation (stability) is not affected. These events are typically 20 to 60 cycles in length, but may be longer if multiple protection operations are required to clear the fault. These events are generally analysed to determine the correct protection operation, fault location or verification of system model parameters.
- Long Term: These include those events that affect system stability such as power swings, frequency variations and abnormal voltage issues. These events are usually analysed to determine causes of incorrect system operations. Data management techniques are employed to process a number of samples and record the value for the parameter of interest. Record length parameters may be defined.
- Steady State: During steady state disturbances, system operation is not threatened, but the power quality is affected. This may include harmonics or produced by the load and/or the interaction between power system's components. Depending on the type of phenomena being analysed, high sample rates may be required to capture the events and data of interest. Record length parameters may be defined.

The three primary types of recording are:

- High-speed disturbance recording: This type is used to capture the individual samples of the currents and voltages measured by the Relay with a high-sampling frequency to display electrical system faults and transients.
- Low-speed disturbance recording: Low-speed recording is typically used to capture short-term and long-term disturbances. Data is typically captured at a rate between 2 times per cycle, and once in every 2 cycles. The data captured is in the form of Phasor or RMS data, and not sampled data.
- Steady State (continuous) recording: Steady state or continuous recording captures average analog quantities such as maximum and minimum values.

Relay works on high speed recording concept

Table 5-2: Oscillography Characteristics

Oscillography Information	
Trigger Points (Configurable)	Pickup / Dropout Alarm / Trip / Trip Reset Digital input / Output change of state Self-test events
Data Parameters (Configurable)	AC input channels Protection element state Digital input state/ Digital output state
Data Parameters Channels	8 No.

Oscillography Information	
Sampling Rate	16 (128 Cycles) / 32 (64 Cycles) / 64 (32 Cycles)
Maximum Records	64
Pre-trigger/Post trigger duration	Programmable

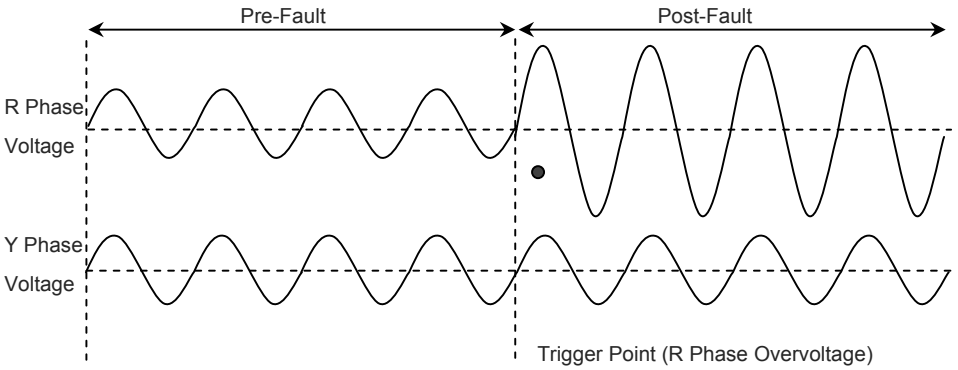


Figure 5-7: Oscillography Recording

Self Diagnostics

The Relay performs self-diagnostics during initialization (after power-up), and continuous as a background task to ensure that every testable unit of the hardware & software is alive and functioning correctly. There are two types of self-test warnings indicating either a minor or a major problem. Minor issues indicate the one with the Relay that does not compromise protection of the power system. Major problems indicate severe issues with the Relay that comprises all aspects of Relay operation.

- CAN communication error
- RTC error
- Hardware Error
- Software error
- Power on self test & on demand test results
- Code (FLASH) memory test
- Configuration Data (FRAM) memory test

Phasor Diagram

The relay plots Phasor diagram for all current and voltage parameters according to the real time measurement of the magnitudes and angles.

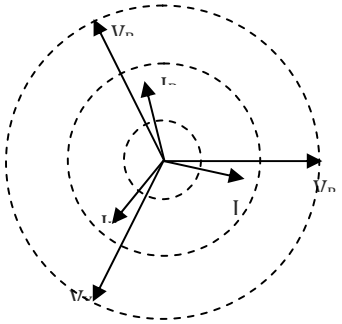


Figure 5-8: Phasor Diagram

Chapter 6

PROTECTIONS

Overview

This section provides a detailed description about various electrical faults in the electrical system, as well as its causes, and preventive measures taken by L&T Relay to protect the feeder. Alarm is an indication that requires immediate attention. It indicates the need for a corrective action to prevent occurrence of any fault. It may result in severe implications, if unnoticed. The alarm-related parameters can be configured for most of the protection functions.

Relay stores data regarding the cause of fault, along with the parameters such as time of fault, source of fault and corresponding values of current, voltage, earth leakage current, power, power factor and frequency. Relay output contact or LED can be configured to operate in any condition for more than one protection function. Logical equation can be derived with protection functions, input status, and timer & latch bits to get the required alarm & trip indications.

Protection function is classified on the basis of following parameters:

- Current based Protections
- Voltage based Protections
- Directional Protections
- Frequency based Protections
- Power based Protections
- Ancillary Protections

Relay detects fault condition, and thereby generates:

- Pickup bit high when an electrical parameter reaches above the set pickup value.
- An alarm bit high when an electrical parameter reaches above the alarm set value.
- Trip bit high if the parameter is above the set pickup value for predefined interval of time (Trip Delay).

In Relay, 4 Groups of protections are available. Changeover of group is possible through any of the command defined in COMPlogic.

Current Based Protections

Instantaneous Overcurrent (50P/50N/50G/50Q)

Overcurrent fault is a condition, wherein current passing through the conductor (power circuit) exceeds its pre-set value. This fault is usually caused due to short circuit, overload, improper connection or fault at ground.

In case of FCOMP, four stages of overcurrent settings are available, which can be enabled individually or all at once, depending on the usage. This protection comprises Phase overcurrent 50P, Neutral overcurrent 50N, Negative sequence overcurrent 50Q and Ground (calculated) overcurrent 50G for respective applications.

Phase Overcurrent (50P) is to protect the feeder whenever any phase current exceeds the configured pickup value.

Neutral Overcurrent (50N) is to protect the feeder in case of any leakage current flowing through the neutral CT for star connected feeders with 3phase 4 wired systems.

Ground Overcurrent (50G) is to protect the feeder from earth leakage current flowing through the feeder in 3 phase systems without Neutral or SEF CT. Earth fault current flowing is calculated by vector summation of 3-phase currents.

Negative sequence Overcurrent (50Q) is to protect the feeder from any unbalance in the phase currents measured from the three phases.

Table 6–1 enlists the Instantaneous Overcurrent settings available in the Relay.

Table 6-1: Instantaneous Overcurrent Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Pickup (xIn)*	1	0.10-20.00	(xIn) Amp
Stage1 Delay*	0.3	0.00-600.00	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

* The similar settings available for other 3 stages & 3 groups.

Timed Overcurrent (51P/51N/51Q/51G)

This protection functions when the AC input current exceeds a predetermined value, and in which the input current & operating time are inversely related to a substantial portion of the performance range. The time to trip is derived from standard Time Inverse Curves.

Curve type available in L&T relay:

- **IEC :** IEC Curve A, IEC Curve B, IEC Curve C
- **IEEE :** Extremely Inverse, Moderately Inverse, Very Inverse

The operating & reset time for IEEE & IEC curves are derived with common formula as

$$\text{Operating Time (t)} = \text{TMS}\left[\frac{k}{\left(\frac{I}{I_P}\right)^{\alpha} - 1} + C\right]$$

$$\text{Reset Time (t)} = \text{TMS}\left[\frac{t_R}{1 - \left(\frac{I}{I_P}\right)^{\alpha}}\right]$$

Where k, C, t_R, α are constants characterizing different the curves

I : Actual Real time current flowing through feeder

I_P : Pickup Setting

TMS: Time Multiplier Settings

Table 6-2: IEC & IEE constants

Curve	Operating Time			Reset Time	
	k	C	α	t_R	α
IEC Curve A – Standard Inverse	0.14	0.02	0	9.3	2
IEC Curve B – Very Inverse	13.5	1	0	43.2	2
IEC Curve C – Extremely Inverse	80	2	0	58.2	2
IEEE Moderately Inverse	0.0515	0.02	0.114	4.85	2
IEEE Very Inverse	19.61	2	0.491	21.6	2
IEEE Extremely Inverse	28.2	2	0.1217	29.1	2

Table 6–3 enlists the Instantaneous Overcurrent settings available in the Relay.

Table 6-3: Timed Overcurrent Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1Curve Type*	IEC Type A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	-
Stage1 Pickup (xIn)*	1	0.10-3.20	(In) Amp
Stage1 Voltage restrain*	Disable	Enable-Disable	-
Stage1 Reset*	Instantaneous	Instantaneous/Auto	-
Stage1 TMS	0.1	0.05-15	-
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

* : The similar settings available for other 1 stage & All 4 groups.

Thermal Overload (49)

Thermal capacity of the feeder is the tolerable capacity that can withstand under overload conditions. In normal conditions, the temperature will eventually stabilise at some steady state temperature (within the limit) due to flow of steady current. Under transient and overload conditions, the thermal capacity of the feeder rises, but only within the corresponding limits. When the overload persists for a considerable amount of time, the temperature and thermal capacity will rise. A trip occurs when the thermal capacity used reaches 100%.

There are many reasons for the increase in the temperature and thermal capacity of the feeder. Fault occurs mainly due to overload, operation on unbalanced condition, poor ventilation, single phasing, short circuits, fault in earthing etc,.The thermal capacity applied is calculated by the following equation for hot and cold curves, respectively.

Cold Curve: A general curve for thermal overload, based on the heating effect and time constant, operating time is derived by the following formula:

$$t = \tau . \ln\left(\frac{I^2}{I^2 - (k.I_B)^2}\right)$$

Where, k: Constant τ: Time constant I_B: Base current

I: Actual Real time current flowing through feeder

Hot Curve: With regard to preheating on Relay with a total memory function, the hot curve is relevant. For example, the equation obtained by modification of the general cold curve is indicated by the following formula:

$$t = \tau . \ln\left(\frac{I^2 - {I_P}^2}{I^2 - (k.I_B)^2}\right)$$

Where I_P : Specified Load current before overload occurs

Table 6-4: Thermal Overload Settings

Parameters	Default Value	Range	Unit
Function	Disable	Enable-Disable	-
Pickup (x In)	0.1	0.1-4.0	-
Pickup Delay	60	60-30000	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%
K constant	100	0.1-4.0	-

Each setting is available for All 4 groups.

Phase Undercurrent (37P)

Undercurrent fault is a state wherein current passing through the conductor (power circuit) reaches below its rated set value. This state is observed mainly during 'No-load'. Table 6–5 enlists the Phase Undercurrent settings available in the Relay.

Table 6-5: Phase Undercurrent Settings

Parameters	Default Value	Range	Unit
Function	Disable	Enable-Disable	-
Pickup (x In)	0.4	0.1-3.2	-
Delay	0.3	0.00-600.00	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

Each setting is available for All 4 groups.

Restricted Earth Fault (64)

A Restricted Earth Fault (REF) means an earth fault in a restricted/localized zone of a circuit. The term 'REF protection method' signifies: not to sense any earth fault outside this restricted zone.

It is a type of 'unit protection' applied to transformers or generators, and is more sensitive than the method known as 'differential protection'. The principal of the REF is based on the detection of zero-sequence current. This detection is only possible in case of fault(s) to ground.

For faults inside the protected zone, the protection has to react (switch-off); and for faults outside the protected zone, a reaction is not requisite. Further, REF has to be able to recognise effects like saturation of a current transformer - in consequence of a large short-circuit current, or aftermath of an inrush current from a power transformer - to avoid any undesirable switch-off command of the protection. Current transformers are utilized similar to a measuring instrument to reduce current to an acceptable level.

A REF Relay functions by measuring the actual current flowing to earth from the frame of the unit. If this exceeds a certain preset maximum value of milliamps (mA), the Relay trips to cut-off the system supply to the unit.

In case of FCOMP, one CT is dedicated for REF, which is sensitive for low values of current, and ranges from 0.02In to 1.2In with+1% accuracy. Table 6–6 enlists the Restricted Earth Fault settings available in the Relay.

Table 6-6: Restricted Earth Fault Settings

Parameters	Default Value	Range	Unit
Function	Disable	Enable-Disable	-
Pickup (x In)	0.05	0.02-1	-
Delay	0.3	0.00-1.00	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

Each setting is available for All 4 groups.

Sensitive Ground Instantaneous Overcurrent Fault (50SG)

Sensitive ground fault is a condition wherein current passing through the CBCT exceeds its pre-set value. This fault is usually caused due to ground fault.

Table 6–8 enlists the Sensitive Ground fault Instantaneous Overcurrent settings available in the Relay.

Table 6-7: Sensitive Instantaneous ground fault Settings

Parameters	Default Value	Range	Unit
Function	Disable	Enable-Disable	-
Pickup (x In)	0.0025	0.0025-1.6	-
Delay	0.3	0.00-600.00	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

Sensitive Ground Timed Overcurrent (51SG)

This protection functions when CBCT current exceeds a predetermined value, and in which the input current & operating time are inversely related to a substantial portion of the performance range. The time to trip is derived from standard Time Inverse Curves.

Curve type available in L&T relay:

- **IEC :** IEC Curve A, IEC Curve B, IEC Curve C
- **IEEE :** Extremely Inverse, Moderately Inverse, Very Inverse

The operating & reset time for IEEE & IEC curves are derived with common formula as

$$\text{Operating Time (t)} = \text{TMS}\left[\frac{k}{\left(\frac{I}{I_P}\right)^{\alpha} - 1} + C\right]$$

$$\text{Reset Time (t)} = \text{TMS}\left[\frac{t_R}{1 - \left(\frac{I}{I_P}\right)^{\alpha}}\right]$$

Where k, C, t_R, α are constants characterizing different the curves

I : Actual Real time current flowing through feeder

I_P : Pickup Setting

TMS: Time Multiplier Settings

Table 6-8: IEC & IEE constants for SEF

Curve	Operating Time			Reset Time	
	k	C	α	t_R	α
IEC Curve A – Standard Inverse	0.14	0.02	0	9.3	2
IEC Curve B – Very Inverse	13.5	1	0	43.2	2
IEC Curve C – Extremely Inverse	80	2	0	58.2	2
IEEE Moderately Inverse	0.0515	0.02	0.114	4.85	2
IEEE Very Inverse	19.61	2	0.491	21.6	2
IEEE Extremely Inverse	28.2	2	0.1217	29.1	2

Table 6–9 enlists the Sensitive Timed Overcurrent settings available in the Relay.
Table 6-9: Sensitive ground fault Settings

Parameters	Default Value	Range	Unit
Function	Disable	Enable-Disable	-
Pickup (x In)	0.0025	0.0025-1.6	-
Stage1Curve Type*	IEC Curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	-
TMS	0.1	0.05 - 15	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

Voltage Based Protections

Overvoltage (59P)

Overvoltage is a condition wherein the voltage in the power circuit rises above its pre-set value. Normally, overvoltage occurs due to internal causes like switching surges, insulation failure, arcing ground and phase loss.

Various causes of overvoltage conditions are as follows:

- Switching surges, produced by switching operations of a loaded as well as unloaded line.
- Arcing ground, which is intermittent arc taking place in line to ground fault in case of a 3-phase system with consequent production of transients.
- Resonance occurs due to 5th or higher harmonics, and in case of underground cables as well, because of distortion of generated EMF wave that causes high voltages in the power system.
- Defective operation of automatic voltage regulator when the generator is in isolated operation.
- Sudden loss of load due to the tripping of outgoing feeders. Leaving the generator isolated or feeding a very small load can cause a sudden rise in the terminal voltage due to the trapped flux and over-speed.
- Operation under manual control, while the voltage regulator out of service. A sudden variation of load, the reactive power component in particular, contributes to a substantial fluctuation in voltage because of the large voltage regulation inherent in a typical alternator.

Table 6-10: Overvoltage Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Pickup (x Vn)*	1.1	0.02-2	-
Stage1 Delay*	2	0.00-600.00	Seconds
Stage1 Curve Type*	Definite time	Definite Time/Inverse Time	-
Stage1 Reset*	0	0.00-600.00	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

* The similar settings available for other 2 stages & All 4 groups.

Undervoltage (27P)

Undervoltage is a condition wherein the voltage in the power circuit drops below 90 per cent of its normal voltage. Generally, undervoltage occurs during heavy electrical demand (during peak hours).

Various causes of undervoltage conditions are as follows:

- Overloaded circuits can result in undervoltage.
- Interruptions due to power system faults, equipment failures and control malfunction.

- Short circuits, often as phase to earth faults (unsymmetrical voltage decrease).
- Due to open circuit fault at delta side of the distribution transformer.
- Starting large loads can cause sag.
- Malfunctioning of voltage regulator or wrong settings under manual control (symmetrical voltage decrease).
- Nature of loads that are being served by utilities. For example, single phase small air-conditioning motors. These small motors tend to stall when subjected to voltage dips caused by transmission system short circuits

Table 6-11: Under voltage Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Pickup (x Vn)*	0.8	0.02-1.2	-
Stage1 Delay*	2	0.00-600.00	Seconds
Stage1 Curve Type*	Definite time	Definite Time/Inverse Time	-
Stage1 Block Voltage (%Vn)*	0	0-75	%
Stage1 Reset*	0	0-600	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

* The similar settings available for other 2 stages & All 4 groups.

Residual Overvoltage (59N)

Relay provides three residual overvoltage elements with independent settings. These elements are used to detect if neutral to earth voltage is measured in an electrical system.

Table 6-12: Residual Overvoltage Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Pickup (x Vn)*	0.05	0.02-1.2	-
Stage1 Delay*	2	0.00-600.00	Seconds
Stage1 Curve Type*	Definite time	Definite Time/Inverse Time	-
Stage1 Reset*	0	0-600	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

* The similar settings available for other 2 stages & All 4 groups.

Sync Under voltage

The Sync input under voltage is used to check the healthiness of the Sync input i.e voltage of other bus or line used in applications like synchronism check, existence of live line or dead bus, and Dead line or Live bus. Sync Undervoltage bit goes high, If sync voltage drops below the pickup value.

Table 6-13: Sync Under voltage Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Pickup (x Vn)*	0.8	0.02-1.2	-
Stage1 Delay*	2	0.00-600.00	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

Each setting is available for All 4 groups.

Sync Overvoltage

The Sync input overvoltage is used to check the healthiness of the Sync input i.e voltage of other bus or line. Sync Overvoltage bit goes high, If sync voltage exceeds above the pickup value.

Table 6-14: Sync Overvoltage Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Pickup (x In)*	1.10	0.02-1.2	-
Stage1 Delay*	2	0.00-600.00	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

Each setting is available for All 4 groups.

Directional Protections

The directional Overcurrent element is made by combining the criteria for Overcurrent element, and the phase displacement between the current and the polarization variable. It provides a selective protection that can be operated in both forward and reverse directions.

Directional Phase Instantaneous Overcurrent (67PI)

Relay provides two phase directional overcurrent elements with independent settings that can operate in either direction.

Relay detects the overcurrent condition, and thereby generates:

- An alarm when the phase current exceeds the alarm set value.
- Trip signal when,

1. The current is greater than threshold (i.e, the forward or reverse pickup)
2. The phase displacement between current and the polarization variable is in/outside the zone between +90° and -90°, respectively, from the characteristic angle, for the reverse and forward directions.

This protection utilises the phase-to-phase voltage as the polarising quantity, as the phase-to-neutral voltage varies greatly when a fault occurs to earth due to the displacement offset of the neutral point.

These elements have wide applications field for the short circuit faults in the closed ring system or networked system. The presence of two directional elements is an added advantage that can be configured to operate for the forward and reverse faults.

To detect the 3-phase faults close to the Relay, it incorporates the voltage memory feature that stores the three cycles of pre-fault voltage data as the polarising voltage. And, it uses this stored voltage to detect the direction.

Table 6-15: Directional Phase instantaneous overcurrent Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Direction	Forward	Forward/Reverse	-
Stage1 Characteristic angle	-180	-180 to 180	Degree
Stage1 Voltage Polarisation	0	0-1.2	-
Stage1 Forward Pickup (x In)*	0.1	0.1-20	Amp
Stage1 Reverse Pickup (x In)*	0.1	0.1-20	Amp
Stage1 Forward Delay*	0.00	0-600	Sec
Stage1 Reverse Delay*	0.00	0-600	Sec
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

* The similar settings available for other 1 stages & All 4 groups

Directional Phase Timed Overcurrent (67PT)

Relay provides two phase directional timed overcurrent elements with independent settings, which can operate in either direction.

This protection functions when the AC input current exceeds a predetermined value and the phase displacement between the current and voltage lies in/outside the zone between +90° to -90°, respectively, from the characteristic angle, and in which the input current and operating time are inversely related through a substantial portion of the performance range. The time to trip is derived from standard Time Inverse Curves as follows:

- **IEC :** IEC Curve A, IEC Curve B, IEC Curve C
- **IEEE :** Extremely Inverse, Moderately Inverse, Very Inverse

Table 6-16: Directional Phase Timed overcurrent Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Direction	Forward	Forward/Reverse	-
Stage1 Characteristic angle	-180	-180 to 180	Degree
Stage1 Voltage Polarisation	0	0-1.2	-
Stage1 Forward Curve type	IEC curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	-
Stage1 Reverse Curve type	IEC curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	-
Stage1 Forward Pickup (x In)*	0.1	0.1-20	Amp
Stage1 Reverse Pickup (x In)*	0.1	0.1-20	Amp
Stage1 Forward Delay*	0.00	0-600	Sec
Stage1 Reverse Delay*	0.00	0-600	Sec
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

* : The similar settings available for other 1 stages & All 4 groups

Directional Neutral Instantaneous Overcurrent (67NI)

Relay provides two Neutral directional overcurrent elements with independent settings. In this case, the directionality is co-existing, i.e; it operates in both forward and the reverse direction.

The residual current and residual voltage is considered in the Neutral directional overcurrent protection. The latter is used as the polarization quantity.

Relay detects the neutral overcurrent conditions, and thereby generates:

- An alarm when the residual current exceeds the threshold value
- Pickup when the residual current exceeds the pickup level and the residual voltage lies in/or outside the zone between +90° to -90°, respectively, from the characteristic angle. And if the pickup flag persists to be 1 till the trip delay expires, it trips.

Table 6-17: Directional Phase instantaneous overcurrent Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Direction	Forward	Forward/Reverse	-
Stage1 Characteristic angle	-90	-90 to 90	Degree
Stage1 Voltage Polarisation	0	0-1.2	-
Stage1 Forward Pickup (x In)*	0.1	0.1-20	Amp
Stage1 Reverse Pickup (x In)*	0.1	0.1-20	Amp
Stage1 Forward Delay*	0.00	0-600	Sec
Stage1 Reverse Delay*	0.00	0-600	Sec
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

* The similar settings available for other 1 stages & All 4 groups

Directional Neutral Timed Overcurrent (67GT)

Relay provides two neutral directional timed overcurrent elements with independent settings.

This protection functions when the AC input current exceeds a predetermined value, and the phase displacement between the current and voltage lies in/outside the zone between +90° to -90°, respectively, from the characteristic angle, and in which the input current and operating time are inversely related through a substantial portion of the performance range. Time to trip is derived from standard Time Inverse Curves.

Curve type available in L&T relay:

- **IEC :** IEC Curve A, IEC Curve B, IEC Curve C
- **IEEE :** Extremely Inverse, Moderately Inverse, Very Inverse

Table 6-18: Directional Neutral Timed overcurrent Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Direction*	Forward	Forward/Reverse	-

Stage1 Characteristic angle	-90	-90 to 90	Degree
Stage1 Voltage Polarisation	0	0-1.2	-
Stage1 Forward Curve type	IEC curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	-
Stage1 Reverse Curve type	IEC curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	-
Stage1 Forward Pickup (x In)*	0.1	0.1-20	Amp
Stage1 Reverse Pickup (x In)*	0.1	0.1-20	Amp
Stage1 Forward Delay*	0.00	0-600	Sec
Stage1 Reverse Delay*	0.00	0-600	Sec
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

*: The similar settings available for other 1 stage & All 4 groups

Frequency Based Protections

The steady state frequency is the main criteria for stability and security in variable interconnected networks within the power system. It is an indicator of the existing balance between the generated power and the load.

Underfrequency (81U)

There will be a reduction in system frequency due to unbalance in the system with the power demand being more than generation. The underfrequency protection effectively detects this situation and helps in load shedding to stabilize the system frequency.For underfrequency protection; the frequency of voltage samples is used for computation and comparison. The blocking voltage concept is used for mal-operation of underfrequency protection when the source is in dead condition.The Relay provides 6 stages of underfrequency elements with independent settings.

Table 6-19: Under frequency Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Pickup*	49.00	20.00-70.00	Hz
Stage1 Delay*	2	0.00-100.00	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

Over frequency (81O)

There will be an increase in system frequency due to the unbalance in the system through the loss of load with the generation being surplus. The overfrequency protection effectively detects this situation and helps in load restoration to stabilize the system frequency.

Table 6-20: Over frequency Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Pickup*	51	20.00-70.00	Hz
Stage1 Delay*	2	0.00-100.00	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

* The similar settings available for other 5 stages & All 4 groups

Frequency Gradient (df/dt Protection) (81R)

The frequency gradient proportionally reflects the severity disorder, which can be utilised effectively in load-shedding plans. The overload is estimated on the basis of average frequency drop gradient. As it provides indication at an early stage, load can be shed in the very first step, thus preventing further frequency drop and its consequential hazards.

Relay provides 6 stages of rate of change of frequency elements with independent settings.

Relay detects any increase or decrease in frequency, or any change in frequency in either direction, depending on the option chosen for the parameter 'Trend'.

Table 6-21: Frequency Gradient Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Trend*	Increasing	Increasing/Decreasing/Both	-
Stage1 Pickup*	0.05	00.01-20.00	Hz/sec
Stage1 OV Supervision (*Vn)*	1.2	0.10-1.20	V
Stage1 Minimum*	20	20-70	Hz
Stage1 Maximum*	70	20-70	Hz
Stage1 Delay*	2	0.00-100.00	Seconds
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

*: The similar settings available for other 5 stages & All 4 groups

Power Based Protections

Under/Over Power (32P)

Relay provides Over/Underpower element which can be utilised in the feeder protection to detect the excessive load or loss of load in the distribution systems. 3 stages of operation are provided to check the variations in active as well as reactive power.

Overpower drop off: 1.05 x setting

Underpower drop off: 0.95 x setting

Table 6-22: Over/Under Power Settings

Parameters	Default Value	Range	Unit
Stage1 Function*	Disable	Enable-Disable	-
Stage1 Under/Over*	Under	Under/Over	
Stage1 Pickup Parameter (W/VAR)*	W	W/VAR	
Stage1 Pickup*	0.3	0.20-1300.00	KW/KVAR
Stage1 Delay*	2	0-600	
Alarm Function	Enable	Enable-Disable	-
Alarm (% pickup)	80	25-80	%

*: The similar settings available for other 2 stages & All 4 groups

Reverse Power (32R)

Reverse power is also called a backfeeding occurs when the power flows in opposite direction of its usual flow. In reverse power condition, the power station delivers power to the power grid in positive cycle of voltage, and inducing it to flow out of the power grid in negative cycle of voltage.

Table 6-23: Reverse Power Settings

Parameters	Default Value	Range	Unit
Function	Disable	Enable-Disable	-
Pickup Parameter (W/VAR)	W	W/VAR	
Pickup	0.3	0.20-1300.00	KW/KVAR
Delay	2	0-600	

Each setting is available for All 4 groups.

Power Factor (55)

If in case of inductive load or capacitive load if the power factor dropps below certain specified level in both lag as well as leading conditions, the relay generates the alarm/trip bit indications for required action to approach power factor to unity.

Table 6-24: Power Factor Settings

Parameters	Default Value	Range	Unit
Lead Power factor			
Function	Disable	Enable-Disable	-
Pickup	0.9	0.05-0.95	-
Delay	10	1-240	sec
Alarm Pickup	0.05	0.05-0.95	-
Alarm Delay	1	1-240	sec
Lag Power factor			
Function	Disable	Enable-Disable	-
Pickup	0.9	0.05-0.95	-
Delay	10	1-240	sec
Alarm Pickup	0.05	0.05-0.95	-
Alarm Delay	1	1-240	sec

Each setting is available for All 4 groups.

Ancillary Protections

Synchrocheck

SynchroCheck is a basic synchronism check carried out between two voltage sources in a power system before closing of a circuit breaker interconnecting both voltage sources. Voltage difference, frequency difference and phase angle difference between the two voltage vectors are checked before allowing the interconnecting circuit breaker to close. If the difference exceeds a certain range, it may lead to loss of power system stability, and may damage the interconnected machines.

A typical example is a two incomer one bus coupler scheme with manual changeover of incoming supply. When any of the two breakers are ON and user want to close third breaker followed by opening of any one of the breaker, Synchrocheck is used to check existing supply with new supply voltage. It generates closing command to the third breaker if supplies are in sync and thereby generates trip command to any one of the breaker by checking momentary paralleling condition.

To undergo SynchroCheck, a fourth input on the VT card is needed for phase-to-phase voltage. The following settings allow selection of the combination of dead and live sources (5 modes; 0-None, 1- Live1 and Dead2, 2- Dead1 and Live2, 3- Dead1 or Dead2, 4- Dead1 Xor Dead2, 5-Dead1 and Dead2) that will bypass SynchroCheck function and permit to close the breaker:

Dead 1 Threshold: Source 1 is 'Dead', If the voltage is below this threshold.

Dead 2 Threshold: Source 2 is 'Dead', If the voltage is below this threshold.

Live 1 Threshold: Source 1 is 'Live', If the voltage is above this threshold

Live 2 Threshold: Source 1 is 'Live', If the voltage is above this threshold.

Table 6-25: Synchrocheck Settings

Parameters	Default Value	Range	Unit
Stage1 Function	Disable	Enable-Disable	-
Stage1 Measurement type	Phase to Phase	Ph-N/Ph- Ph	-
Stage1 Mode	None	0-5	-
Stage1 Voltage Difference	10	1-240	V
Stage1 Angle Difference	10	0-120	deg
Stage1 Frequency Difference	1	0-3.00	Hz

* The similar settings available for other 1 stages & All 4 groups

Second Harmonic Blocking

The second harmonic feature is needed in feeder protection relays for feeders connected to transformers. Whenever a transformer connected to a feeder is energized, it draws a large initial magnetizing current, which may be several times more than the rated current of a transformer. This current is known as the magnetizing inrush current. Due to heavy magnitude of the inrush current, it may be above the pickup level of the OverCurrent elements, which causes trip. So, once the inrush condition is detected, all OverCurrent elements are blocked.

The harmonic contents in the inrush current are different from those of a normal fault current. The DC offset range varies from 40 to 60%; the second harmonic content varies from 15 to 70%; and the third harmonic content varies from 10 to 30%. Other harmonics are progressively less. The third harmonic and its multiples do not appear in the CT leads, as these circulate in the delta winding of the transformer and the delta connected CTs connected on the star winding of the transformer.

Hence, the second harmonic content is utilized for detecting the inrush condition. The second harmonic level may not be same for all the phases during inrush, and therefore, phase inrush blocking is used where blocking signal being will be transmitted if any one of the phases detects second harmonic content above the threshold value. The ratio of second harmonic current to the fundamental current is being applied for detection.

Table 6-26: Second harmonic blocking Settings

Parameters	Default Value	Range	Unit
Function	Disable	Enable-Disable	-
Pickup	20	10-70	-

Cold Load Pickup

Cold load settings group is required at all stages of non-directional and directional OverCurrent elements.

The term 'cold load pickup' refers to the increased level of currents due to restoration of power after a long interruption. Generally, when a distribution circuit is restored after an extended outage, demand is greater than what it was before the outage. Attempting to pickup this load can be tough because the initial load demand after an outage can exceed the load demand that is observed at any time before the outage. This cold load condition can be caused due to loss of diversity following an extended outage, opening of the circuit breaker, or loss of supply, even if the breaker remains closed. Diversity refers to the percentage of independently controlled, cyclic loads that may be energized at any given time during normal circuit operation - 1 of 2 would be 50% diversity.

Loss of load diversity is a part of cold load pickup that occurs when distribution circuits are restored, following sustained outages of several minutes to several hours. After the load is energized, current level shoots up instantly around 5-6 times the normal level due to magnetizing inrush currents in transformers, thereby accelerating currents in motors and enduring current due to loss of normal load diversity.

The factors that determine the magnitude and duration of cold load pickup are: outage duration, types of connected load, weather, restoration mode, outage causes & the presence of distributed generation and/or automatic transfer schemes, time of day, and load level. In most cases, as cold load pickup current is greater than percentage current, it affects fault detection. In other words, protective Relays can misinterpret the cold load pickup condition as a fault and initiate de-energisation of a non-faulty circuit. Cold load pickup current can be high enough to cause instantaneous OverCurrent and/or timed OverCurrent protection to maloperate. To prevent this, cold load condition is set.

Table 6-27: Cold Load Pickup Settings

Parameters	Default Value	Range	Unit
Function	Disable	Enable-Disable	-
Open delay	0	0-1500	-
Active delay	10	10-15000	sec

Breaker Failure

During faulty conditions in a power system, the breaker needs to be tripped to isolate the faulty part of the power system network. At times, the circuit breaker may fail to trip. The method to detect breaker failure condition is as follows:

- Breaker auxiliary contacts detecting the breaker status closed (breaker is closed) even after the timer (timer value = breaker tripping time + a buffer) has expired and fault current keep flowing concludes that the breaker has not tripped resulting in failure of clearing the fault.
- The solution for this is LBB protection (Local Breaker Backup protection). If the downstream breaker fails to clear the fault, a DO is fed from the downstream breaker as DI of the upstream breaker to trip it. A user-configurable provision for breaker failure alarm is available.

Table 6-28: Breaker Failure Settings

Parameters	Default Value	Range	Unit
Function	Disable	Enable-Disable	-
DI selection Requirement	No	Yes-No	-
DI Selection	1	0-30	-

Auto-Recloser

As the name suggests, auto-reclosure denotes reclosing of circuit breaker contacts automatically once it gets tripped or opened due to any fault in the system. It is recommended to be used in the feeders where the frequency of transient faults such as insulator flash over or semi-permanent faults such as a tree branch falling on the line are more. In case of semi-permanent occurrence, the fault would not be removed by immediate tripping of the breaker, but could be burnt away during a time delayed trip.

Tentatively, 80% of the overhead line faults are transient in nature, and in such cases autoreclosing is beneficial, as it eliminates loss of supply from such faults, and allows a particular substation run unattended. Thus, the number of visits by personnel to reclose a circuit breaker manually, after a fault occurs, could be substantially reduced - which is an important consideration for substations in remote areas. For feeders where a significant portion of faults are permanent, for example, broken conductors, transformer faults, cable faults or machine faults, auto-reclosure is not considered as the right alternative, since reclosing on to a faulty cable is likely to aggravate the damage.

On HV/MV distribution networks, auto-reclosure is applied mainly to radial feeders where system stability issues do not generally arise. The system conditions to be met for closing are: whether the system voltages are in synchronism or dead line/live bus or live line/dead bus conditions exist, indicated by the internal check synchronizing element; and that the circuit breaker closing spring, or other energy source, is fully charged.

Auto-reclosure may be of single phase or 3-phase type. Mostly, single phase auto reclosing breakers are preferred, as most of the transmission faults are of single phase to ground faults. Auto-reclosure improves stability, as power is transmitted through the two healthy phases when one phase is interrupted.

- Dead timer: It is the time between the breakers tripping and reclosing again. This time should be sufficient enough to be allowed after tripping for the fault arc to de-energise prior to reclosing, or the arc will re-strike. The dead time depends on the line voltage, breaker and type of fault occurring in the line frequently.
- Reclaim timer: It is the time delay provided once the breaker closes, which should be in excess of the time delayed protection operating time to ensure that the protection can operate before the auto-reclosure function is reset. During this time, if the breaker is tripped due to protection or

manually, the Auto-reclosure (A/R) either advances to the next shot (if it is programmed for multi-shots), or goes to lockout if all programmed reclose attempts have been made. The reclaim timer starts once the CB has physically closed. If there is no trip before the reclaim timer expires, the A/R function resets at the end of the timer.

- Lockout: Lockout means the breaker is opened permanently and auto-reclosure is blocked. It can be set either manually or get set after all the A/R shots are completed. It is necessary to reset from lockout to reset the autoreclose function.

Table 6-29: Auto-reclosure Settings

Parameters	Default Value	Range	Unit
Function	Disable	Enable-Disable	-
No. Of shots	4	0-4	-
Dead Time	0.1	0.1-100	Sec
Reclaim time	0.1	0.1-100	Sec

CT Supervision

The intent of CT supervision feature is to detect if any issue occurs in current transformer secondary circuits. In case of CT failure in one or multiple phases, faulty information about current flow in the Relay, leads to mal-operation of main protection functions. The supervision function must be sensitive & fast to detect the condition and prevent unwanted tripping of some sensitive protections. On detection of a CT failure condition, the protection elements that work on derived values (differential, ground fault, negative sequence OverCurrent and broken conductor) are blocked. An alarm is generated if configured.

Table 6-30: CT Supervision Settings

Parameters	Default Value	Range	Unit
Function	Disable	Enable/Disable	-
Inhibit setting (* In)	0.2	0 -1.00	A
Time delay	0	0 - 500 sec	Sec
Threshold setting (* In)	0.7	0 -1.00	A

Loss of Phase or Fuse Failure

The Relay declares an LOP if there is 25% drop for 60 cycles in the measured positive-sequence volt with no corresponding magnitude or angle change in positive or negative or zero sequence currents. This provides information if the VT fuse of one or more than one phase blown out.

Table 6-31: LOP or Fuse Fail Settings

Parameters	Default Value	Range	Unit
Function	Disable	Enable-Disable	-

Chapter 7
COMMUNICATION

Overview

Relay consists of multiple ports for communication. The front port is the local configuration utilised to communicate with COMPfigurator & COMPlogic. This communication is carried out on Modbus RTU protocol. The rear ports are to communicate with the system on a higher level, such as EWS /DCS/SCADA. In this case, communication is carried out on Modbus RTU, Modbus TCP/IP, Profibus, IEC 61850 protocols. Communication interface is the physical connection on a device. Once the physical connection is established, Relay communicates with the master on a protocol.

The section below provides a detailed description of Communication Interface, Communication Protocols and Communication Architecture of different protocols applied in the Relay.

Communication Interface

Relay communicates with DCS/SCADA using Different communication protocols with different communication interfaces Listed in Table 7-1. Selection of communication protocol & Interface is depending on application.

Table 7-1: Communication Interface & Protocols

Communication Interface	Protocol	Connector Type	Location
Serial	Modbus RTU	USB B type	Relay Front panel
Serial	Modbus RTU	RS-485, 5 - Screw terminal	Processor card
Ethernet	Modbus TCP/IP	Dual RJ45/1 no. FO	Processor card
Serial	Modbus RTU or Profibus	Dual RS-485, 5 -screw terminals (Modbus)/ 1 no. 9-Pin D Connector (Profibus)	Communication card
Ethernet	IEC 61850	Dual RJ45/Dual FO	Communication card

Communication Protocols

Modubus RTU

Overview

Modbus is a serial protocol that supports communication between a single master device and multiple slave devices. In a Modbus network, the protocol governs how each IED shall know its device address, recognise a message addressed to it, determine the kind of action to be taken, and extract any data or other information contained in the message. If a reply is required, the IED will construct the reply message and send it using Modbus protocol. Table 7–2 shows Relay Modbus RTU port connections.

Table 7-2: 5-wire screw terminal for modbus RTU

Pin No.	Standard RS-485 Signal for DB9 Connector	Description	Connection Required	5 Wire Screw terminal connection: Pins for the respected terminals
1	GND	Common Ground	Yes	5
2	CTS+	Clear to Send+	NA	NA
3	RTS+	Ready to Send+	NA	NA
4	RxD+	Receive Data+	Yes	4
5	RxD-	Receive Data-	Yes	3
6	CTS-	Clear to Send-	NA	NA
7	RTS-	Ready to Send-	NA	NA
8	TxD+	Transmitted Data+	Yes	1
9	TxD-	Transmitted Data-	Yes	2

The Modbus RTU message is a simple 8-bit binary code which allows more data exchange for the same baud rate as compared to ASCII message indicated in Figure 7-1

Address	Function Code	Data Number	Data 1	----	Data n	CRC Low Order Byte	CRC High Order Byte

Figure 7-1: Modbus RTU Serial Message

In case of Relay, Modbus communication allows a Modbus Master device to:

- Acquire metering, monitoring and event data from the Relay.
- Control Relay output contacts.
- Aquire Relay files system data for diagnostic.

Supported Modbus Function Code

Table 7–3 lists the function codes supported by the Relay on Modbus:

Table 7-3: Modbus Function Code

Codes	Discriptions
01	Read Coil Status
03	Read Input Status
04	Read Input Registers
05	Force Single Coil
06	Single Coil register write
16	Multiple parameter writing
41	Event Log (User defined Function Code)
42	Data Recorder (User defined Function Code)
43	Oscillography (User defined Function Code)

Relay Coil Status - 01

Description - Reads the ON/OFF status of discrete outputs (0X references, coils) in the Slave.

Query - The query message specifies the starting coil and quantity of coils to be read. Coils are addressed starting at zero: coils 1-16 are addressed as 0-15. Table 7–4 below is an example of a request to read coils 20-56 from Slave device 17.

Table 7-4: Read Coil Query

Field Name	(Hex)
Slave Address	11
Function	01
Starting Address High	00
Starting Address Low	13
No. of Points High	00
No. of Points Low	25
Error Check (LRC or CRC)	-

Response - The coil status in the response message is packed as one coil per bit of the data field. Status is indicated as: 1 = ON; 0 = OFF. The LSB of the first data byte contains the coil addressed in the query. The other coils follow towards the high order end of this byte, and from 'low order to high order' in subsequent bytes.

If the returned coil quantity is not a multiple of eight, the remaining bits in the final data byte will be padded with zeros (towards the high order end of the byte). The Byte Count Field specifies the quantity of complete bytes of data. The Table 7–5 below shows the Read Coil Status response to the query.

Table 7-5: Read Coil Response

Field Name	(Hex)
Slave Address	11
Function	01
Byte Count	05
Data (Coils 27-20)	CD
Data (Coils 35-28)	6B
Data (Coils 43-36)	B2
Data (Coils 51-44)	0E
Data (Coils 56-52)	1B
Error Check (LRC or CRC)	-

The status of coils 27-20 is shown as the byte value CD hex, or binary 1100 1101. Coil 27 is the MSB of this byte and coil 20 is the LSB. From left to right, the status of coils 27 through 20 is: ON-ON-OFF-OFF-ON-ON-OFF-ON.

By convention, bits within a byte are shown with MSB to the left and LSB to the right. Thus the coils in the first byte are '27 through 20', from left to right. The next byte has coils '35 through 28', left to right. As bits are transmitted serially, these flow from LSB to MSB: 20 . . . 27, 28 . . . 35 and so on.

In the last data byte, status of coils 56-52 is shown as byte value 1B hex, or binary 0001 1011. Coil 56 is in the fourth bit position from the left and coil 52 is the LSB of this byte. The status of coils 56 through 52 is: ON-ON-OFF-ON-ON. Here, note how the three remaining bits (toward the high order end) are zero-filled.

Read Holding Registers - 03

Description - It reads the binary contents of holding registers (4X references) from Slave device.

Query - The query message specifies the starting register and quantity of registers to be read. Registers are addressed starting from zero: Registers 1-16 are addressed as 0-15. Table 7–6 below shows an example of a request to read registers 40108-40110 from Slave device 17.

Table 7-6: Read Holding Register Query

Field Name	(Hex)
Slave Address	11
Function	03
Starting Address High	00
Starting Address Low	6B

No. of Points High	00
No. of Points Low	03
Error Check (LRC or CRC)	-

Response - The register data in the response message is packed as two bytes per register with the binary contents aligned as right-justified within each byte. For each register the first byte contains high-order bits, and the second comprises of low order bits. Data is scanned from the Slave device at the rate of 125 registers per scan for 984-X8X controllers (984-685, etc,.) and at the rate of 32 registers per scan for all other controllers. The response is returned when the data is completely assembled. Table 7–7 shows an example of a response to the query.

Table 7-7: Read Holding Register Response

Field Name	(Hex)
Slave Address	11
Function	01
Byte Count	05
Data (Coils 27-20)	CD
Data (Coils 35-28)	6B
Data (Coils 43-36)	B2
Data (Coils 51-44)	0E
Field Name	**(Hex)**
Data (Coils 56-52)	1B
Error Check (LRC or CRC)	-

The contents of register 40108 are shown as the two byte values of 02 2B hex or 555 decimal. The contents of registers 40109-40110 are 00 00 and 00 64 hex or 0 and 100 decimal.

Read Input Registers - 04

Description - Reads the binary contents of input registers (3X references) from Slave device.

Query - The query message specifies the starting register and quantity of registers to be read. Registers are addressed starting from zero: Registers 1-16 are addressed as 0-15. Table 7–8 shows an example of a request to read register 30009 from Slave device 17.

Table 7-8: Read Input Register Query

Field Name	(Hex)
Slave Address	11
Function	04
Starting Address High	00
Starting Address Low	08

No. of Points High	00
No. of Points Low	01
Error Check (LRC or CRC)	-

Response - The register data in the response message are packed as two bytes per register, with the binary contents as right-justified within each byte. For each register, the first byte contains the high-order bits, and the second contains the low- order bits.

Data is scanned from the Slave device at the rate of 125 registers per scan for 984-X8X controllers (984-685, etc,.) and at the rate of 32 registers per scan for all other controllers. The response is returned when the data is completely assembled. Table 7–9 shows the Read Holding Register response to the query.

Table 7-9: Read Input Register Response

Field Name	(Hex)
Slave Address	11
Function	04
Byte Count	02
Data High (Register 30009)	00
Data Low (Register 30009)	0A
Error Check (LRC or CRC)	-

The contents of register 30009 are shown as two byte values of 00 0A hex or of 10 decimal.

Force Coil – 05

Description - Forces a single coil (0X reference) either to ON or OFF mode. When broadcast, the function forces the same coil reference in all attached Slave device.

Query - The query message specifies the coil reference to be forced. Coils are addressed starting from zero: coil 1 is addressed as 0. The requested ON/OFF state is specified by a constant in the query data field. A value of FF 00 hex requests the coil to be turned ON. A value of 00 00 requests it to be turned OFF. All other values are illegal and will not affect the coil. Table 7–10 shows an example of a request to force coil 173 ON in slave device 17.

Table 7-10: Force Coil Query

Field Name	(Hex)
Slave Address	11
Function	05
Coil Address High	00
Coil Address Low	AC
Force Data High	FF

Force Data Low	00
Error Check (LRC or CRC)	-

Response - The normal response is an echo of the query, returned after the coil state has been forced. Table 7–11 shows a response to the query.

Table 7-11: Force Coil Response

Field Name	(Hex)
Slave Address	11
Function	05
Coil Address High	00
Coil Address Low	AC
Force Data High	FF
Force Data Low	00
Error Check (LRC or CRC)	-

Write Single Register -06

Description – writes a value into single holding register.

Query - The request message specifies the register reference to be written. Registers are addressed starting from zero: Register 1 is addressed as 0. The requested Write value will be specified in the request data field. Table 7–12 shows an example of a request to write register 40002 to 00 03 Hex in slave device 17.

Table 7-12: Write Single Register Query

Field Name	(Hex)
Header	None
Slave Address	11
Function	6
Register Address High	0
Register Address Low	1
Write Data High	0
Write Data Low	3
Error Check Low	9A
Error Check High	9B

Response - The normal response is an echo of the request, returned after the register contents have been written. Table 7–13 shows a response to the query.

Table 7-13: Write Single Register Response

Field Name	(Hex)
Header	None
Slave Address	11
Function	06
Coil Address High	00
Address Low	01
Write Data High	00
Write Data Low	03
Error Check Low	9A
Error Check High	9B

Write Multiple Registers -16

Description - Writes values into a sequence of holding registers

Query - The request message specifies the register references to be written. Registers are addressed starting from zero: Register 1 is addressed as 0. The requested Write values are specified in the request data field. Data is packed as two bytes per register. Table 7–14 shows an example of a request to write two registers starting at 40002 to 00 0A and 01 02 hex, in slave device 17.

Table 7-14: Write Multiple Register Query

Field Name	(Hex)
Header	None
Slave Address	11
Function	10
Starting Address High	00
Starting Address Low	01
Quantity of Registers High	00
Quantity of Registers Low	02
Byte Count	04
Data High	00
Data Low	0A

Data High	01
Data Low	02
Error Check Low	C6
Error Check High	F0

Response -The normal response returns the slave address, function code, starting address, and quantity of registers written. Table 7–15 shows an example of a response to the request.

Table 7-15: Write Single Register Response

Field Name	(Hex)
Header	None
Slave Address	11
Function	10
Starting Address High	00
Starting Address Low	01
Quantity of Registers High	00
Quantity of Registers Low	02
Error Check Low	12
Error Check High	98

Modbus RTU Settings

Modbus requires communication parameters such as baud rate, parity, node address, etc, to be set for establishing a successful communication with the master. Table 7–16 shows Modbus RTU communication protocol settings.

The communication parameter settings available in Relay are shown below:

- **Mode:** It defines the mode of communication (ASCII or RTU). The Relay supports only RTU mode.
- **Node Address:** It defines the node address of Relay.
- **Baud Rate:** It defines the speed at which Relay communicates with Modbus Master.
- **Parity:** Parity can be set as even, odd or none.
- **Stop Bits:** Number of Stop Bits used can be set as one or two.

Table 7-16: Modbus RTU settings

Parameter	Setting Range	Step Increase	Factory Setting
Mode	RTU	-	RTU
Node Address	1-247	1	1

Baud rate	19200-38400	19200	38400
Parity	Even, Odd, None	-	None
Stop bit	1, 2	-	2

Modbus Memory Map

Modbus RTU memory map enlists all metering parameters, trip & event record parameters, DI/DO status and coil status. Function codes for different registers are also mentioned. The Modbus RTU memory map shows the addresses for slow scan parameters. The addresses for fast scan parameters will range from 30001 to 30016, which cannot be changed. Different parameters can be configured as fast scan parameters at these addresses through COMPfigurator.

Please refer Annexture A for modbus memory map.

Modbus TCP/IP

Overview

Modbus TCP/IP shares the same application layer as the Modbus RTU, however, with a different physical layer (Ethernet). Transmission Control Protocol (TCP) and Internet protocol (IP) govern the data traffic control on the Ethernet media. In other words, Modbus TCP/IP uses a Modbus RTU message transmitted with a TCP/IP envelope, which is send over a network instead of serial lines. The Server does not have a Slave ID, instead it uses an IP Address. The table below shows Modbus TCP/IP port connections in Relay.

Relay communicates on Modbus TCP/IP using RJ45 port. Category 5 (Cat 5) cables, which support speed up to 100 Mbps are generally utilised for connection. Table 7–25 shows Relay Modbus TCP/IP port connection.

Table 7-17: Modbus TCP/IP Connection

Pin No.	Standard Signal	Description	Connection Required	Relay Pin	Relay Signal
1	Tx+	Transmit Data +	Yes	1	Tx+
2	Tx-	Transmit Data -	Yes	2	Tx-
3	Rx+	Receive Data+	Yes	3	Rx+
4	NC	Not Connected	No	4	NA
5	NC	Not Connected	No	5	NA
6	Rx-	Receive Data-	Yes	6	Rx-
7	NC	Not Connected	No	7	NA
8	NC	Not Connected	No	8	NA

Modbus TCP/IP Settings

Modbus TCP/IP requires certain communication parameters to be set for establishing a successful communication with the master. The table below shows Modbus TCP/IP communication protocol settings available in Relay.

Relay supports Time synchronisation using Simple Network Time protocol (SNTP). To utilise this feature, the SNTP server address and the proper time zone must be entered in Relay settings as shown in the table below. The time zone is set as per the location of the user. In India, the time zone applied is GMT+5h 30m. Table 7–26 shows Modbus TCP/IP communication protocol settings.

Table 7-18: Modbus Function Code

Parameter	Setting Range	Step Increase	Factory Setting
Mode (DHCP)	Enable/Disable	-	Enable
IP Address	0.0.0.0 to 255.255.255.255	1	10.7.212.135
Subnet Mask	0.0.0.0 to 255.255.255.255	1	255.255.255.0
Default Gateway	0.0.0.0 to 255.255.255.255	1	0.0.0.0
SNTP Server Address	0.0.0.0 to 255.255.255.255	1	0.0.0.0
Time Zone	± 0 to 13 hours & 0-59 minutes		

Profibus DP

Overview

Profibus is an open, vendor-independent, field bus protocol. The Relay supports Profibus DP-V0 protocol for cyclic data exchanges between master and slave devices. The Profibus DP-V1 protocol for acyclic data exchange is supported by the Relay as an optional feature.

PROFIBUS DP is a network that consists of two types of devices connected to the bus, master devices and slave devices. It is a bi-directional network, meaning that one device, a master, sends a request to a slave, and the slave responds to that request.

Table 7-19: Profibus Port Connection

Pin No.	Standard Signal	Description	Connection Required	Relay Pin	Relay Signal
1	GND	Common Ground	No	1	NA
2	CTS+	Clear To Send+	No	2	NA
3	RTS+	Ready To Send+	No	3	NA
4	RxD+	Received Data+	Yes	4	D+
5	RxD-	Received Data-	Yes	5	D□
6	CTS-	Clear To Send-	No	6	NA
7	RTS-	Ready To Send-	No	7	NA

8	TxD+	Transmitted Data+	No	8	NA
9	TxD-	Transmitted Data-	No	9	NA

Profibus Settings

Profibus requires communication parameters to be set for establishing Successful communication with the master having following setting ranges.

Table 7-20: Profibus Setting

Parameter	Setting Range	Step Increase	Factory Setting
Mode	Enable/Disable	-	Enable
Node Address	1-126	1	110

The communication parameter settings available are shown below:

Node Address: To define the node address of the Relay.

Baud Rate: Baud rate is governed by the Profibus.

Profibus Memory Map

Table 8–22 shows Profibus memory map of the Relay used during parameterization in Profibus mater. The parameters can be selected from the GSD file provided by the manufacturer of the Relay. GSD modules are discussed in Modules available in GSD file.

Please refer Annexture A for modbus memory map.

IEC 61850

Overview

IEC 61850 is the international standard originally designed for the integration of electric utility substation devices. It supports multivendor IEDs that are networked to perform functions like protection, metering, automation and control. Over here IED refers to microcontrollers for power system equipment that are classified by their functions such as relays, circuit breakers, recloser etc. IEC 61850 provides a comprehensive model which contains object oriented data and the method for its data transfer. The transfer is carried over TCP/IP networks or substation LANs using high speed switched Ethernet.

Key Points -

- Cost effective solution due to reduced physical wiring
- No external protocol converters are required
- Easy to upgrade
- Flexible programming
- Lower installation cost
- Eliminate procurement ambiguity
- Highly interoperable between systems of different vendors
- Less Latency

- Common data storage format i.e. Substation configuration description language (SCL)

This appendix provide details of IEC 61850 standard from a conceptual point of view. We present our understanding of the IEC 61850 standard, the implementation of the protocol in FCOMP relay and use of our L&T configuration tool for transferring the Substation Configuration Language (SCL)/Configured IED Description (CID) file to the FCOMP relay.

Structure of IEC61850

The standard IEC 61850 has an impact on all activities related to the field of protection and substation automation, but the main issues are how to implement the standard in practice and how to benefit from the potential the standard has.

Substation Architecture & ACSI

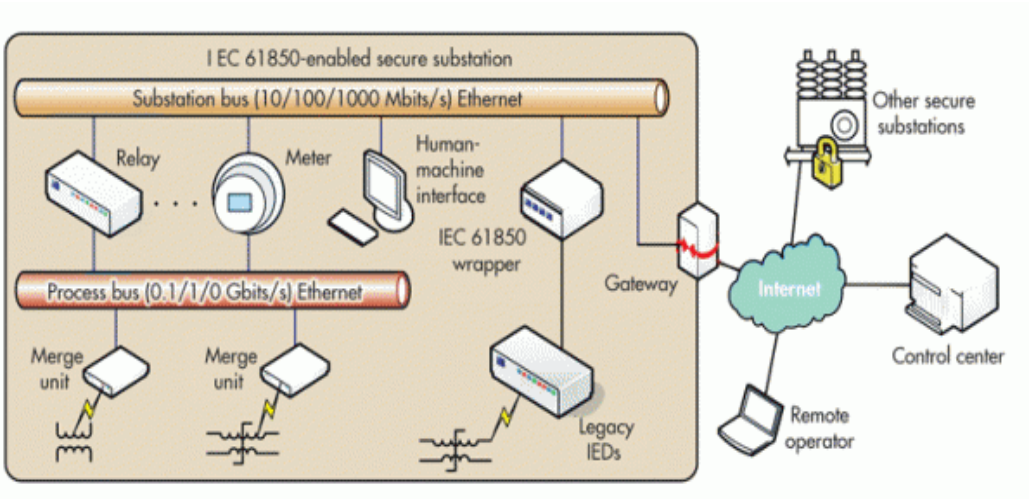


Figure 7-2: System architecture with IEC61850

In the above figure, IEC 61850 envisions a substation network connected to the outside wide area network via a secure gateway. Outside remote operators and control centers can use the abstract communication service interface (ACSI) to query and control IEDs in the substation. One or more substation buses, in the form of medium bandwidth Ethernet network connect all the IEDs inside the substation. The substation bus carries all ACSI requests and responses as well as generic substation events messages (GSE).A separate, high bandwidth Ethernet process bus handles communication inside each bay and connect the IEDs to any dumb devices. A substation would typically have a single global substation bus and multiple process buses, one for each bay.

Communication inside a substation automation system involves data gathering and setting, data monitoring, reporting and event logging. To accomplish this, the standard defines a communication structure. There are four communication profiles in addition to ACSI: the generic object oriented substation event profile (GOOSE), the generic substation status event (GSSE), the sampled measured value multicast profile (SMV) and the time synchronization profile.

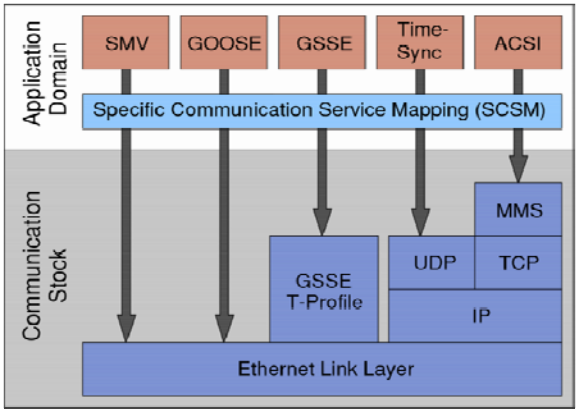


Figure 7-3: Communication Profiles

ACSI services enable client-server interaction between applications and servers. GOOSE provides a fast way to exchange data on the substation bus. GSSE provides a method for substation-level status exchange. Applications request all ACSI services and servers respond to them. The server is a common point that links physical devices and logical objects.

Object Modeling

The Abstract Communication Service Interface (ACSI) model defines a set of service and the responses to those services. These abstract models are used to create objects (data items) and services that exist independently of any underlying protocols. A data is assigned to a logical node that produces or consumes the values of the data object, this means for example: Data consisting of calculated values of current and voltage are assigned to the logical node "measurement unit". The composition of DATA is based on common templates (the common data class, CDC), which describes the type and structure of each element within a logical node. Common data classes provide useful means to reduce the size of data definitions. The data definition does not need to list all the attributes but needs to just reference the common data class. CDCs for status, measurement, controllable analog and status and settings have unique CDC attributes.

Each physical device can contain many logical devices and each logical device can contain many logical nodes. Each logical node represents a group of data (controls, status, measurements, etc.) associated with a particular function. For example, the MMXU logical node (measurement unit) contains measurement data and other points associated with three-phase metering including voltages and currents. Each IED may contain many functions such as protection, metering, and control. Multiple logical nodes represent the functions in multifunction devices.

Table 7-21: Object Model Example

Object Model		
Components	**Object Name**	**Description**
Logical Device	FCOMP_PRO	Protection
Logical Node	XCBR1	Circuit-breaker 1
Data	Pos	Position
Data attributes	stVal	Status value

Data Mapping

The FCOMP logical nodes are grouped under Logical Devices based on function. Table 7-3 shows Logical Devices in FCOMP. Chapter- Logical Nodes depicts LNs that make up these Logical Devices.

Table 7-22: FCOMP Logical devices

Logical Device	Description
FCOMP_CFG	Configuration elements-datasets and report control blocks
FCOMP_PRO	Protection related parameters
FCOMP_MET	Metering related parameters
FCOMP_ANN	Annunciation related parameters
FCOMP_CON	Control related parameters

MMS (Manufacturing Message Specification)

MMS (Manufacturing Message Specification) includes services for the application-layer exchange of real-time data indications, control operations & report notifications. A protocol that implements ACSI must be able to do a few basic things, such as reading, writing, spontaneously sending reports, and naming data using text strings. MMS or Manufacturing Message Specification (ISO 9506) was the first protocol for which an implementation of ACSI was defined.

GSE (Generic Substation Events)

The IEC 61850 standard allows for communication between devices within a substation where a peer-to-peer model for Generic Substation Events (GSE) services is used for fast and reliable communication between Intelligent Electronic Devices (IEDs). GSE is again subdivided into GOOSE & GSSE. For time-critical events such as protection, messages known as Generic Object-Oriented Substation Event (GOOSE) messages are exchanged between devices by means of a local Ethernet network. Generic Substation State Event (GSSE) provides the capability to convey state change information.

Virtual bits (VB001–VB128) are control inputs that you can map to GOOSE receive messages using the L&T configuration software. If you intend to use any FCOMP virtual bits for controls, you must create COMPlogic equations to define these operations.

File Services

The File system provides a means for the devices to transfer data as files. The File system supports FTP (File Transfer Protocol).

SCL (Substation Configuration Language)

Substation Configuration Language (SCL) is an XML-based configuration language used to support the exchange of database configuration between different tools, which may come from different manufacturers. There are four types of SCL files:

IED Capability Description file (ICD)

The ICD file described the capabilities of an IED, including information on Logical node and GOOSE support

System Specification Description file (SSD)

The SSD file describes the single-line diagram of the substation.

Substation Configuration Description file (SCD)

SCD file contains information on all IEDs, configuration data, and a substation description

Configured IED Description file (CID)

CID file describes a single instantiated IED within the project, and includes various address information

Dataset

We have thirteen predefined datasets in FCOMP. However with the help of L&T Configuration tool, User can configure datasets by either editing or deleting them. The default list of datasets for FCOMP is as given below:

Table 7-23: FCOMP Data Sets

Datasets	Description
DSet01	Metering
DSet02	Virtual bits
DSet03	Contact Outputs
DSet04	Contact Outputs
DSet05	Contact Outputs
DSet06	Contact Outputs
DSet07	Contact Outputs
DSet08	Protection
DSet09	Metering
DSet10	Contact Outputs
DSet11	Metering
DSet12	Metering
DSet13	Metering

Reports

FCOMP supports both buffered and unbuffered report control blocks in the report model as defined in IEC61850. There are 12 report control blocks- six buffered reports and six unbuffered reports. Unique dataset is assigned for each report control block.

Table 7-24: FCOMP Reports type

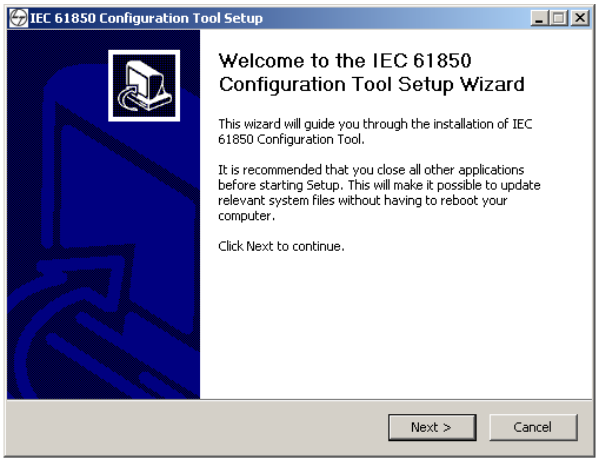
Name	Description	Data Set
BRep01	Predefined Buffered Report 01	DSet01
BRep02	Predefined Buffered Report 02	DSet02
BRep03	Predefined Buffered Report 03	DSet03
BRep04	Predefined Buffered Report 04	DSet04
BRep05	Predefined Buffered Report 05	DSet05
BRep06	Predefined Buffered Report 06	DSet06
URep01	Predefined Unbuffered Report 01	DSet07
URep02	Predefined Unbuffered Report 02	DSet08
URep03	Predefined Unbuffered Report 03	DSet09
URep04	Predefined Unbuffered Report 04	DSet10
URep05	Predefined Unbuffered Report 05	DSet11
URep06	Predefined Unbuffered Report 06	DSet12

IEC 61850 Configuration

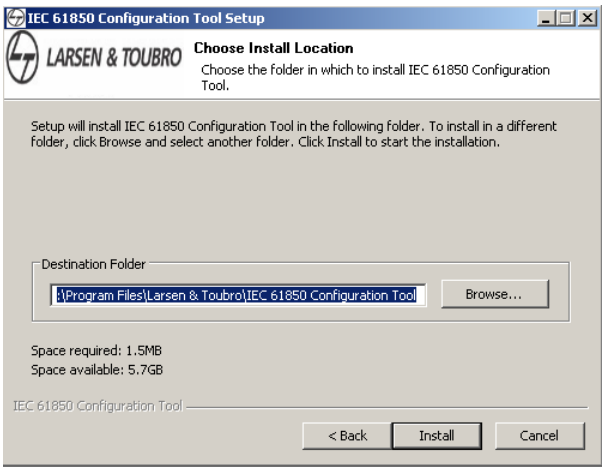
Steps to install configuration software

1. Click on the software setup icon for installation as shown in the figure below

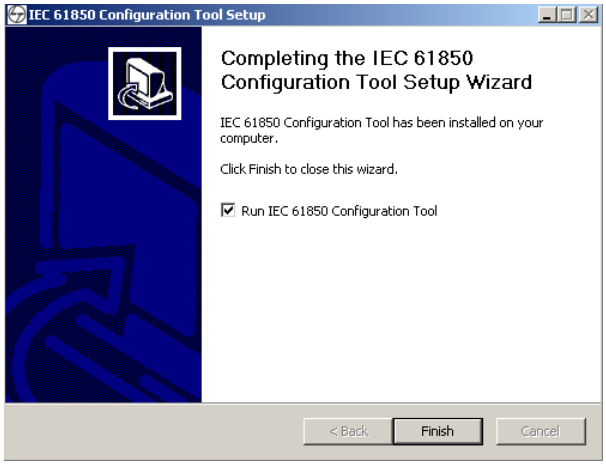
2. Next screen appears as shown below. Now click on “Next”.



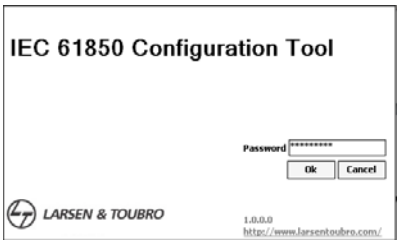
3. Below screen shall appear. Select the path to install software. Click on “install”.



4. Software is installed now. Click on “Finish” to complete the process.



5. Double click on the icon of installed software on your desktop. You will be prompted for password of the software. Enter the password and click on "ok".



L&T Configuration Software-COMPmanagerTM

The L&T IEC 61850 Configuration Tool will be used to configure L&T IEC 61850 based devices for substation automation. Tool helps User to map data from remote Goose into L&T IED data.

L&T IEC 61850 Configuration Tool has split based window layout. Configuration Tool has project creation, editing and saving. Windows can be resized for convenience.

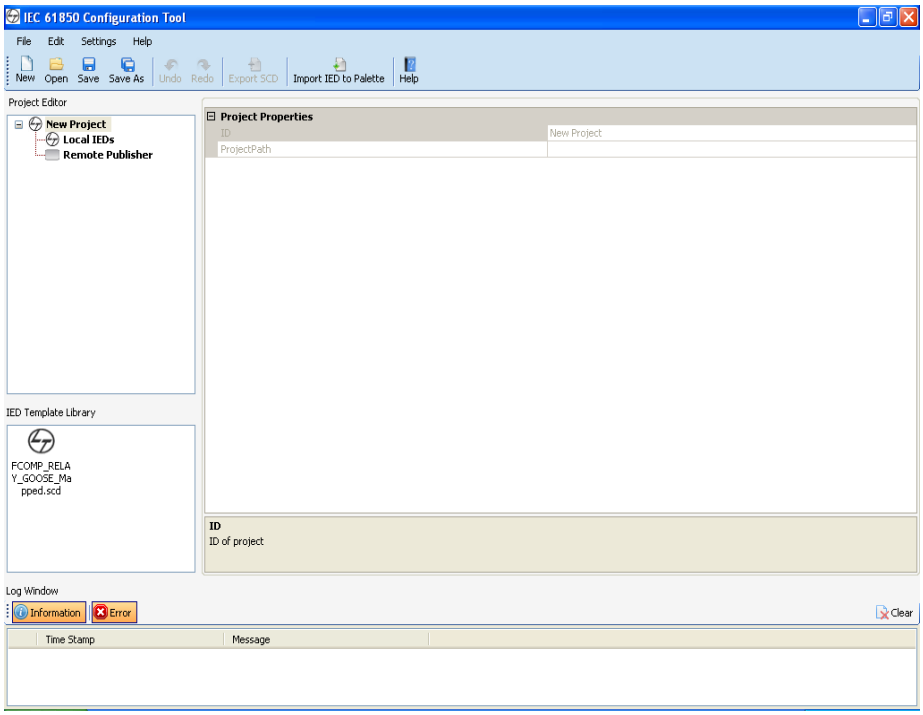


Figure 7-4: COMPmanager Main Window

The Configurator screen is divided into four parts.

- **Project Editor-** It lists all the local and remote IEDs.
- **Configuration Editor-** It contains IED Properties editor, GOOSE subscription mapping, IED Configuration and Startup properties editor.
- **IED Template Library-** IED template library shall store and display SCL files for project creation.
- **Log window -** It displays history of events and error for the present project.

Project Editor:

Project Editor lists all the local and remote IEDs added for a project created in the Configuration tool. A new project in Configuration tool shall open an empty project editor.

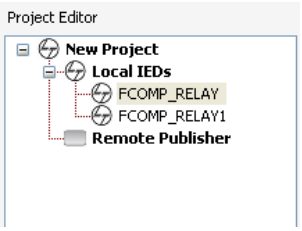


Figure 7-5: Project Editor Window

IEDs can be added to Project from IED Palette. After you add a new IED, configuration tool displays an icon representing the new IED in the Project Editor.

Adding IED to Project:

You can add IEDs to the project by dragging IED product from IED template library and dropping it in the project editor. After dropping into project editor user will be asked for selecting the IED as shown below.

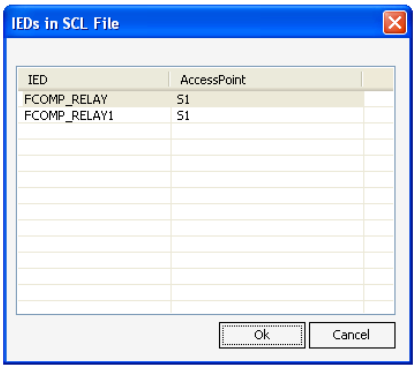


Figure 7-6: IEDs in SCL file

User shall click Ok to finish the process. Now the all IEDs will be added to project and shown in the project editor. If the manufacturer of the IED is Larsen & Toubro it will be added under the node Local IEDs otherwise under the node Remote Publisher. You can distinguish between Local IEDs and Remote Publisher by the different icons.

Functions available for an IED in project:

User has the functions Send SCD, Export SCD for all local IEDs. Send SCD shall send the SCD file of selected IED with all subscription to IED via ftp.

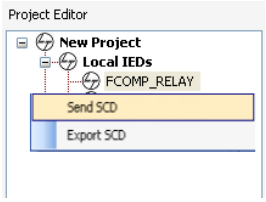


Figure 7-7: IED functions in COMPmanager

Configurations Editor Properties:

Each IEDs added to project have a set of properties. These include Name, Type, Manufacturer, Description etc. The IP Address indicates the IP Address of L&T IED. All ftp related operations of an IED will be referring to this address.

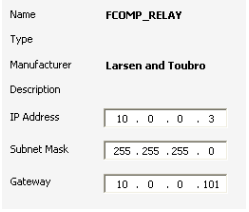


Figure 7-8: IED communication properties

Goose Mapping

This configuration screen allows the user to map the desired data from GOOSE publication to 61850 inputs of the selected IED in the project editor.

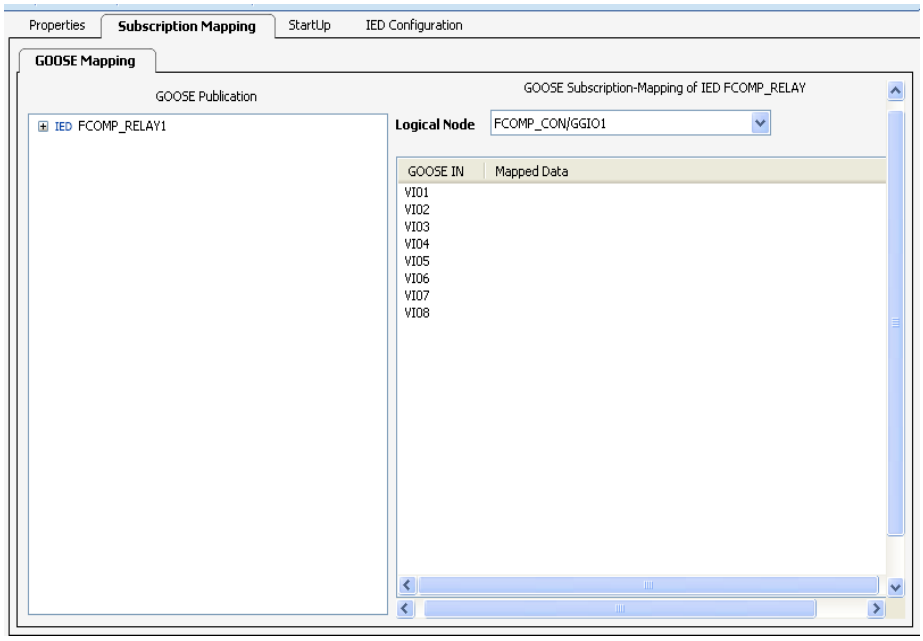


Figure 7-9: Goose Mapping Window

In the GOOSE Publication section the display is in the following format

Level1 - <IEDName>

Level2-<LogicalDeviceName>.<GOOSE Name>

Level3 -<DataSet>

Level4 -<LogicalDeviceName>/<FCDA>

FCDA: Functionally Constraint Data Attribute

In the GOOSE Subscription-Mapping section the listview displays boolean data items from any logical node with lnClass="GGIO" and inst="1"

Data Mapping

User can browse through the GOOSE publication to identify the desired data item then drag it and drop on the desired 61850 input on the GOOSE Subscription Mapping section.

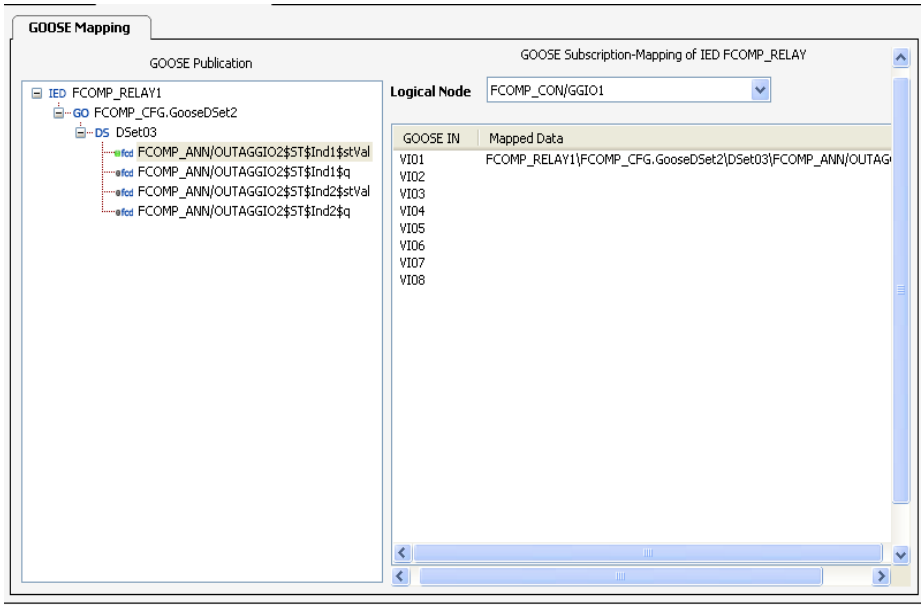


Figure 7-10: Data Mapping Window

User can remove the mapping of a data item by right clicking the mapped data item and using the function Remove Mapping.

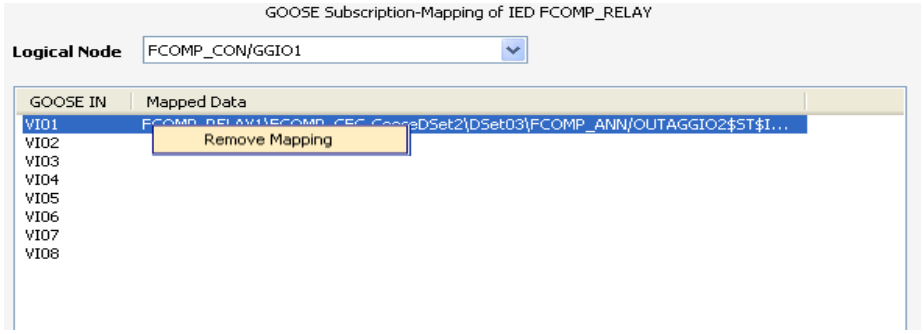


Figure 7-11: Removal of data mapping

Goose Control Blocks configuration

This displays the GOOSE control blocks' details. The publisher part shows the GOOSE control blocks details in the selected IED in project editor.

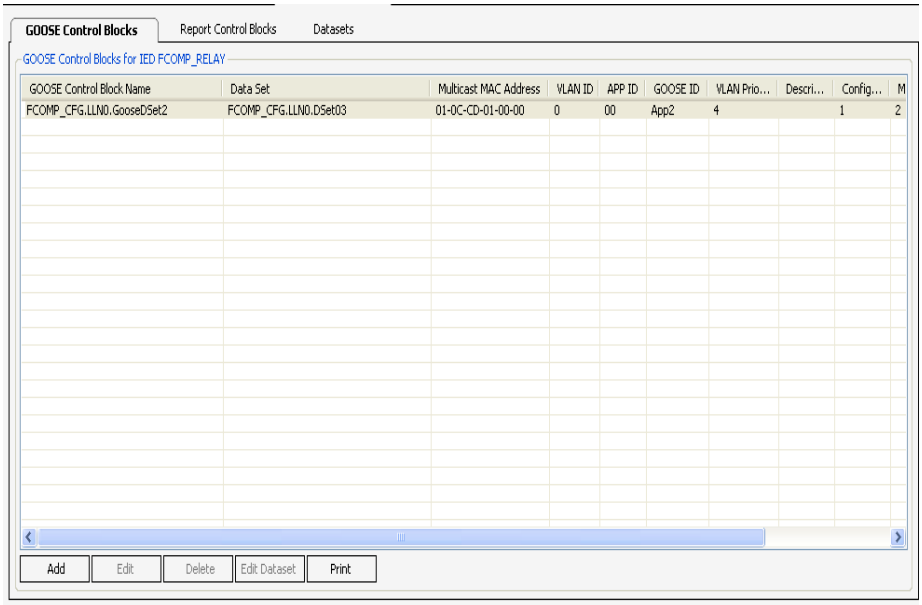


Figure 7-12: Goose control block configuration

Adding a GOOSE Control Block:

Click on the Add button in the GOOSE Control Blocks Configuration screen which will display the screen shown below from which user has to select the logical device to which GOOSE control block has to be added.

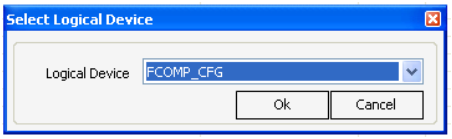


Figure 7-13: Addition of Goose control block

After selecting the logical device, below shown screen will be displayed.

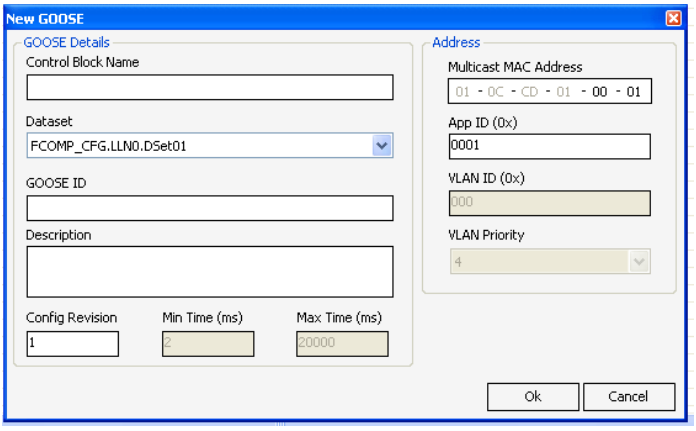


Figure 7-14: Adding Goose details

Editing a GOOSE Control Block:

Select the GOOSE Control Block from GOOSE Control Block Configuration screen. Now either double clicking on the selected GOOSE or clicking Edit button will display the Edit GOOSE screen where user can edit the GOOSE details.

Deleting a GOOSE Control Block:

Select the GOOSE Control Block from GOOSE Control Block Configuration screen and click on delete button.

Note: If the selected GOOSE Control Block is used for mapping purpose in other IEDs the delete request will be rejected as shown below.

Report Control Blocks Configuration

This screen shows the buffered and unbuffered reports of the selected IED. This also provides the user to add, edit, and delete Report control blocks.

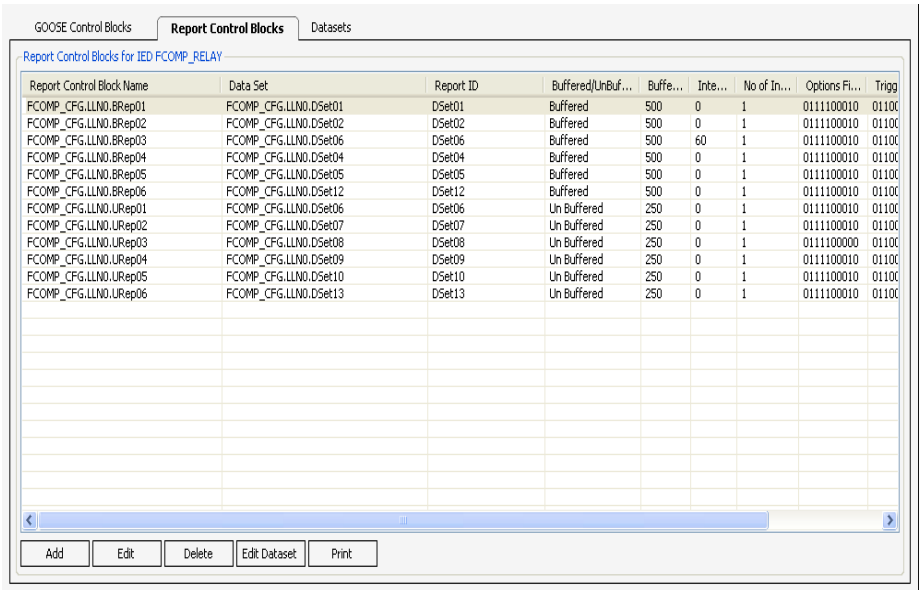


Figure 7-15: Report Control Blocks

Bitstring format for displaying RCB Options fileds and Trigger Options:

In IED Configurator the RCB Options fields are displayed in bitstring format as shown below

Options Fields	Trigger Options
0111110110	010010

Figure 7-16: Fields in Report Control Blocks

RCB Options Fields are displayed in the following order of bits

ACSI value of BRCState	MMS bit position
Reserved	0
sequence-number	1
report-time-stamp	2
reason-for-inclusion	3
data-set-name	4
data-reference	5
buffer-overflow	6
entryID	7
conf-revision	8
segmentation	9

Figure 7-17: Bit indication in RCB Optional fields

RCB Trigger options are displayed in the following order of bits

Bit 0 Reserved (reserved to provide backward compatibility with UCA 2.0)
Bit 1 data-change
Bit 2 quality-change
Bit 3 data-update
Bit 4 integrity
Bit 5 general-interrogation

Figure 7-18: Bit indication in RCB trigger fields

Adding a Report Control Block

To add a Report Control Block, click on Add button. Below shown screen will be displayed.

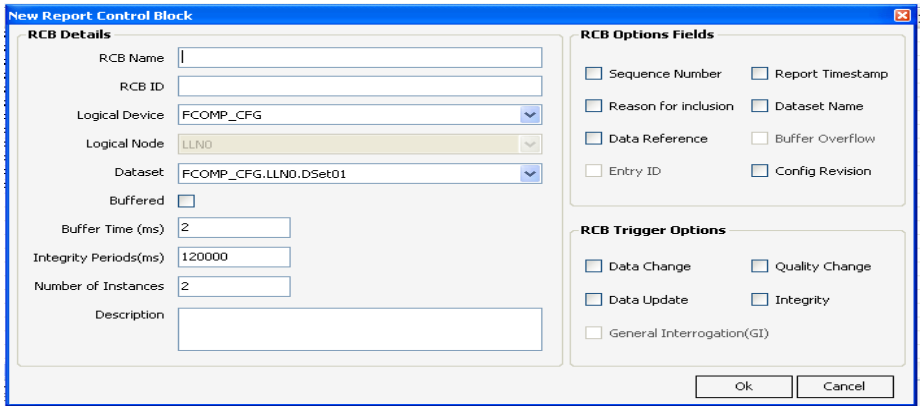


Figure 7-19: Addition of report control block

User can enter the Report Control Block details in this screen. User can select to which logical device report control block has to be added. Datasets from the LLN0 of selected the logical device will be listed in the dataset drop down. After entering the details, user has to click Ok button. Please note that all report control block shall be created in LLN0 of logical device.

Field Name	Min	Max
Buffer Time	0 ms	3600000 ms
Integrity Period	0 ms	1800000 ms
Number Of Instances	1	16

Table 7-4: Read Coil Query

Editing a Report Control Block

Select the Report Control Block from Report Control Block Configuration screen. Now either double clicking on the selected Report Control Block or clicking Edit button will display the Edit RCB screen where user can edit the Report control block details.

Deleting a Report Control Block

Select the Report Control Block from Report Control Block Configuration screen and click on delete button. User will be asked to confirm the action.

Printing Report Control Blocks information

User shall print report control blocks information using Print button.

Datasets Configuration

This configuration screen displays all the datasets in a list, IED Data Items of the selected IED and the dataset items of the selected dataset.

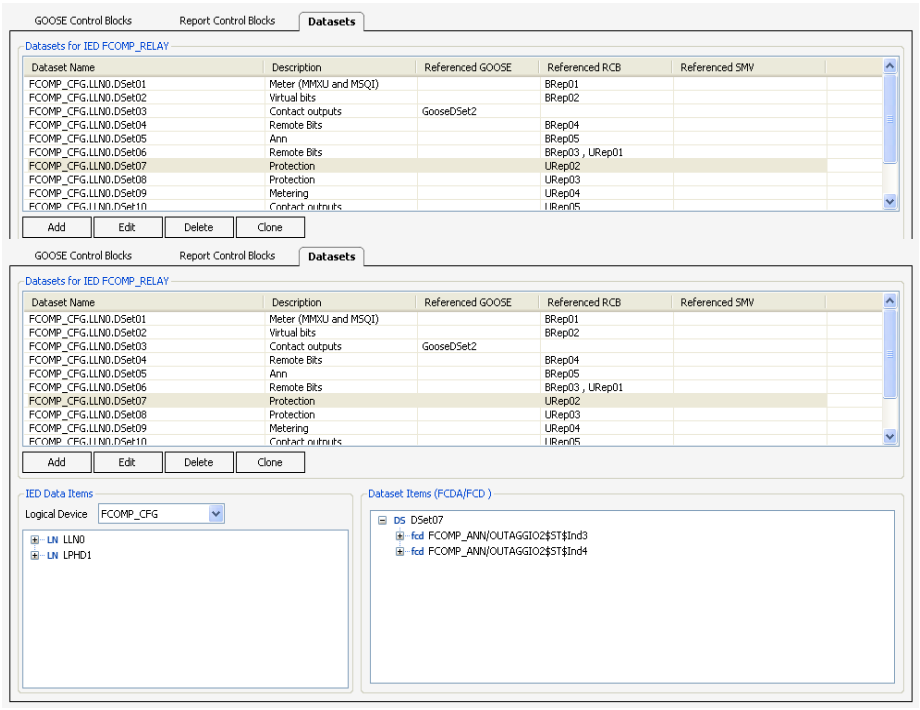


Figure 7-20: Datasets configuration window

Adding a Dataset:

User can add a new dataset by clicking on Add button. User shall enter the dataset details and click on Ok button. The data set will be added to the selected logical node (logical node is fixed as LLN0) in selected logical device. (Note that while adding the dataset user is not selecting the data items (FCDA/FCD) for the dataset. This can be later configured from the Datasets Configuration screen).

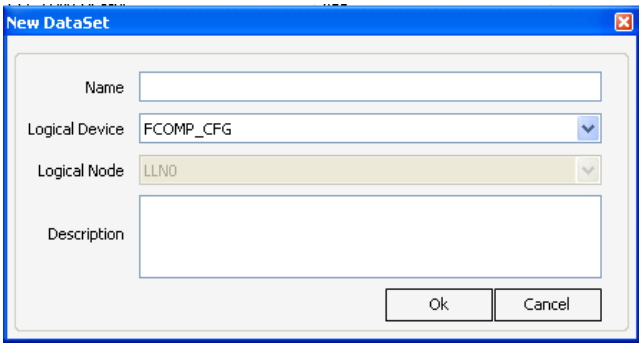


Figure 7-21: Addition of Datasets

Configuring a Dataset

User can select the dataset to be edited from the list.

Dataset Items (FCDA/FCD) section shows the data items present in the selected dataset. IED Data items shows the Logical devices and logical nodes in the logical device. User can select the desired data object or data attribute from the logical node and drag it and drop in the Dataset items (FCDA/FCD) section.

Editing a Dataset

User can change the description of a dataset by editing the dataset.

Deleting a Dataset

User shall select the desired dataset from the list and click on Delete button. User will be asked to confirm the action.

If the dataset is referenced by a GOOSE control block or Report control block it cannot be deleted.

Figure 7-22: Deletion of Datasets

Cloning a Dataset:

This functionality is for creating a dataset from an existing dataset. User can select the desired dataset from the drop down list to be cloned and click on Clone button. User can see the below shown screen in which the dataset name and description are entered.

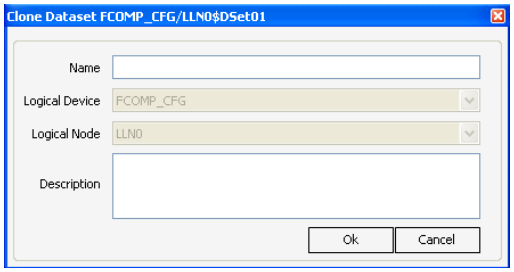


Figure 7-23: Cloning of Datasets

COMPmanager Settings

IED Template Library:

IED Template Library shall store and display L&T IED templates as well as other remote IEDs. ICD files will be allowed to be imported as templates.

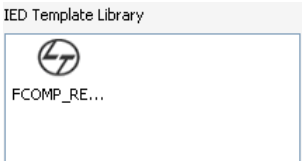


Figure 7-24:IED template

You can import new IED template to IED Palette using the functionality Import IED. User will get the below shown menu when right clicking on the IED Palette.

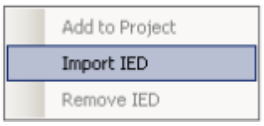


Figure 7-25: Importing IED

You can browse the desired file to be added to the IED Palette.

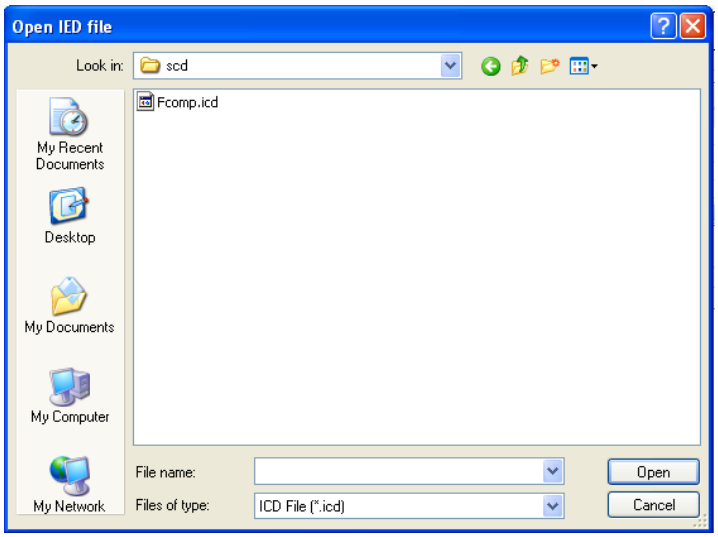


Figure 7-26: Browsing .icd file

Log Window:

This window will show the different information and errors related to IED Configurator.

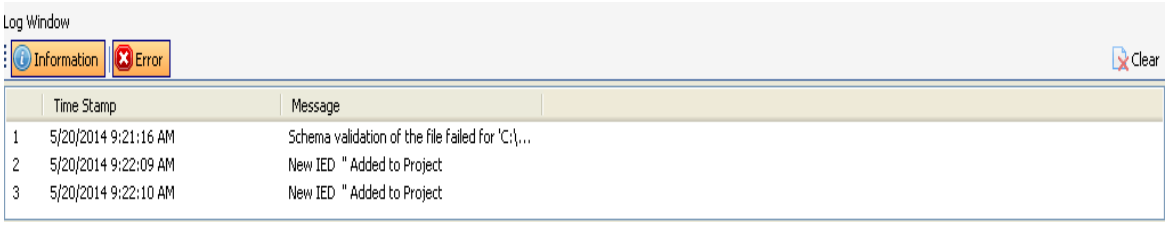


Figure 7-27: Log Window

Chapter 8

SETTING SHEET

Overview

These settings sheets include the definition and input range for each setting in the Relay. You can access the settings from the Relay front panel and the Communication protocols.

Product Setup

Date & Time

Parameters	Default Value	Range	Unit
Date	1	1-31	=_____
Month	1	1-12	=_____
Year	2010	2010-2999	=_____
Hour	0	0-23	=_____
Minute	0	0-59	=_____
Second	0	0-59	=_____
Millisecond	0	0-999	=_____

Demand

Parameters	Default Value	Range	Unit
Current Demand Method	Thermal Exponential	Thermal Exponential/ Block Interval/ Rolling Demand	=_____
Power Demand Method	Thermal Exponential	Thermal Exponential/ Block Interval/ Rolling Demand	=_____
Interval Time	15	15/45/60 min	=_____
Sliding Window	5	5/10/15 min	=_____

Communication Settings

Modbus Serial Setting

Parameters	Default Value	Range	Unit
Node Address	1	1-247	=_____
Parity	None	None/Odd/Even	=_____
Baud Rate	38400	300//600/1200/2400 /4800/9600/19200/38400	=_____
Stop Bits	1	1-2	=_____

Modbus TCP/IP Setting

Parameters	Default Value	Range	Unit
IP Address 0 (Low)	135	0-255	=_____
IP Address 1	212	0-255	=_____
IP Address 2	7	0-255	=_____
IP Address 3 (High)	10	0-255	=_____
IP Subnet Mask 0	0	0-255	=_____
IP Subnet Mask 1	255	0-255	=_____
IP Subnet Mask 2	255	0-255	=_____
IP Subnet Mask 3	255	0-255	=_____
Gateway IP Address 0	1	0-255	=_____
Gateway IP Address 1	212	0-255	=_____
Gateway IP Address 2	7	0-255	=_____
Gateway IP Address 3	10	0-255	=_____
OSI Network Address 0	0	0-255	=_____
OSI Network Address 1	0	0-255	=_____
OSI Network Address 2	0	0-255	=_____
OSI Network Address 3	0	0-255	=_____

Profibus Setting

Parameters	Default Value	Range	Unit
Function	Disable	Enable/Disable	=_____
Node Address	1	1-126	=_____

IEC 61850 Setting

Parameters	Default Value	Range	Unit
IP Address 0 (Low)	0	0-255	=_____
IP Address 1	0	0-255	=_____
IP Address 2	0	0-255	=_____
IP Address 3 (High)	0	0-255	=_____
IP Subnet Mask 0	0	0-255	=_____
IP Subnet Mask 1	255	0-255	=_____
IP Subnet Mask 2	255	0-255	=_____
IP Subnet Mask 3	255	0-255	=_____
Gateway IP Address 0	0	0-255	=_____
Gateway IP Address 1	0	0-255	=_____
Gateway IP Address 2	0	0-255	=_____
Gateway IP Address 3	0	0-255	=_____
OSI Network Address 0	0	0-255	=_____
OSI Network Address 1	0	0-255	=_____
OSI Network Address 2	0	0-255	=_____
OSI Network Address 3	0	0-255	=_____

System Settings

Current Ratio

Parameters	Default Value	Range	Unit
Phase CT Primary	1	1-50000	=_____
Phase CT Secondary	1 A	1 A / 5 A	=_____
SEF/Neutral CT Primary	1	1-50000	=_____
SEF/Neutral CT Secondary	1 A	1 A / 5 A	=_____
REF CT Primary	1	1-50000	=_____
REF CT Secondary	1 A	1 A / 5 A	=_____
Neutral/ SEF Selection	Neutral	Neutral/SEF	=_____

Voltage Ratio

Parameters	Default Value	Range	Unit
Phase VT Connection	Star	Star/Open Delta	=_____
Phase VT Primary (Ph-N)	239.60	1-24000	=_____
Phase VT Secondary (Ph-N)	63.5	1-300	=_____
Nominal Frequency	50	50/60	=_____
Phase Rotation	RYB	RYB/RBY	=_____

Group Settings

Parameters	Default Value	Range	Unit
Setting Group Change Delay	60	60-400 sec	=_____
Setting Group 1	ON	ON/OFF/Control Equation	=_____
Setting Group 2	OFF	ON/OFF/Control Equation	=_____
Setting Group 3	OFF	ON/OFF/Control Equation	=_____
Setting Group 4	OFF	ON/OFF/Control Equation	=_____

Protection Settings

Current Based Protections

Parameters	Default Value	Range	Unit
Phase Instantaneous OverCurrent (50P)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Pickup	1.00 In	0.1-20 In A	=_____
Stage1 Delay	0.3	0.00-600.00	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Pickup	1.00 In	0.1-20 In A	=_____
Stage2 Delay	0.3	0.00-600.00	=_____
Stage3 Function	Disable	Enable/Disable	=_____
Stage3 Pickup	1.00 In	0.1-20 In A	=_____
Stage3 Delay	0.3	0.00-600.00	=_____
Stage4 Function	Disable	Enable/Disable	=_____
Stage4 Pickup	1.00 In	0.1-20 In A	=_____
Stage4 Delay	0.3	0.00-600.00	=_____
Alarm Function	Enable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Neutral Instantaneous OverCurrent (50N)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Pickup	0.10 In	0.1-20 In A	=_____
Stage1 Delay	0.3	0.00-600.00	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Pickup	0.10 In	0.1-20 In A	=_____
Stage2 Delay	0.3	0.00-600.00	=_____
Stage3 Function	Disable	Enable/Disable	=_____
Stage3 Pickup	0.10 In	0.1-20 In A	=_____
Stage3 Delay	0.3	0.00-600.00	=_____
Stage4 Function	Disable	Enable/Disable	=_____

Parameters	Default Value	Range	Unit
Neutral Instantaneous OverCurrent (50N)			**Continued…**
Stage4 Pickup	0.10 In	0.1-20 In A	=_____
Stage4 Delay	0.3	0.00-600.00	=_____
Alarm Function	Enable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Ground Instantaneous OverCurrent (50G)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Pickup	0.10 In	0.1-20 In A	=_____
Stage1 Delay	0.3	0.00-600.00	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Pickup	0.10 In	0.1-20 In A	=_____
Stage2 Delay	0.3	0.00-600.00	=_____
Stage3 Function	Disable	Enable/Disable	=_____
Stage3 Pickup	0.10 In	0.1-20 In A	=_____
Stage3 Delay	0.3	0.00-600.00	=_____
Stage4 Function	Disable	Enable/Disable	=_____
Stage4 Pickup	0.10 In	0.1-20 In A	=_____
Stage4 Delay	0.3	0.00-600.00	=_____
Alarm Function	Enable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Negative Sequence Instantaneous OverCurrent (50Q)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Pickup	0.10 In	0.1-20 In A	=_____
Stage1 Delay	0.3	0.00-600.00	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Pickup	0.10 In	0.1-20 In A	=_____
Stage2 Delay	0.3	0.00-600.00	=_____

Parameters	Default Value	Range	Unit
Negative Sequence Instantaneous OverCurrent (50Q)			**Continued…**
Stage3 Function	Disable	Enable/Disable	=_____
Stage3 Pickup	0.10 In	0.1-20 In A	=_____
Stage3 Delay	0.3	0.00-600.00	=_____
Stage4 Function	Disable	Enable/Disable	=_____
Stage4 Pickup	0.10 In	0.1-20 In A	=_____
Stage4 Delay	0.3	0.00-600.00	=_____
Alarm Function	Enable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Sensitive Instantaneous OverCurrent (50SG)			
Function	Disable	Enable/Disable	=_____
Pickup	0.0025 In	0.0025-1.6 In A	=_____
Delay	0.3	0.00-600.00	=_____
Alarm Function	Enable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Phase Time OverCurrent (51P)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Curve type	IEC Type A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage1 Pickup	1 In	0.1-3.2 In A	=_____
Stage1 Voltage Restrain	Disable	Enable/Disable	=_____
Stage1 Reset	Instantaneous	Instantaneous/Timed	=_____
Stage1 TMS	0.1	0.05-15	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Curve type	IEC Type A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage2 Pickup	1 In	0.1-3.2 In A	=_____

Parameters	Default Value	Range	Unit
Phase Time OverCurrent (51P)			**Continued…**
Stage2 Voltage Restrain	Disable	Enable/Disable	=_____
Stage2 Reset	Instantaneous	Instantaneous/Timed	=_____
Stage2 TMS	0.1	0.05-15	=_____
Alarm Function	Enable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Neutral Time OverCurrent (51N)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Curve type	IEC Type A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage1 Pickup	0.1 In	0.1-3.2 In A	=_____
Stage1 Voltage Restrain	Disable	Enable/Disable	=_____
Stage1 Reset	Instantaneous	Instantaneous/Timed	=_____
Stage1 TMS	1	0.05-15	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Curve type	IEC Type A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage2 Pickup	0.1 In	0.1-3.2 In A	=_____
Stage2 Voltage Restrain	Disable	Enable/Disable	=_____
Stage2 Reset	Instantaneous	Instantaneous/Timed	=_____
Stage2 TMS	1	0.05-15	=_____
Alarm Function	Enable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Ground Time OverCurrent (51G)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Curve type	IEC Type A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____

Parameters	Default Value	Range	Unit
Ground Time OverCurrent (51G)			**Continued…**
Stage1 Pickup	0.1 In	0.1-3.2 In A	=_____
Stage1 Voltage Restrain	Disable	Enable/Disable	=_____
Stage1 Reset	Instantaneous	Instantaneous/Timed	=_____
Stage1 TMS	1	0.05-15	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Curve type	IEC Type A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage2 Pickup	0.1 In	0.1-3.2 In A	=_____
Stage2 Voltage Restrain	Disable	Enable/Disable	=_____
Stage2 Reset	Instantaneous	Instantaneous/Timed	=_____
Stage2 TMS	1	0.05-15	=_____
Alarm Function	Enable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Negative Sequence Time OverCurrent (51Q)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Curve type	IEC Type A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage1 Pickup	0.1 In	0.1-3.2 In A	=_____
Stage1 Voltage Restrain	Disable	Enable/Disable	=_____
Stage1 Reset	Instantaneous	Instantaneous/Timed	=_____
Stage1 TMS	1	0.05-15	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Curve type	IEC Type A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage2 Pickup	0.1 In	0.1-3.2 In A	=_____
Stage2 Voltage Restrain	Disable	Enable/Disable	=_____
Stage2 Reset	Instantaneous	Instantaneous/Timed	=_____

Parameters	Default Value	Range	Unit
Negative Sequence Time OverCurrent (51Q)			**Continued…**
Stage2 TMS	1	0.05-15	=_____
Alarm Function	Enable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Phase UnderCurrent (37P)			
Function	Disable	Enable/Disable	=_____
Pickup	0.4 In	0.1-20 In A	=_____
Delay	2	0.00-600.00	=_____
Alarm Function	Enable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Restricted Earth Fault			
Function	Disable	Enable/Disable	=_____
Pickup	0.02 In	0.02-1 In A	=_____
Delay	0.3	0.00-600.00	=_____
Alarm Function	Enable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Thermal Overload (49)			
Function	Disable	Enable/Disable	=_____
Pickup	0.1 In	0.1-4 In A	=_____
Delay	60	60-30000 Seconds	=_____
K-Constant	0.10	0.1-4.00	=_____
Alarm Function	Enable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____

Voltage Based Protections

Parameters	Default Value	Range	Unit
Phase Undervoltage (27P)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Pickup	0.8 Vn	0.02-1.2 %Vn V	=_____
Stage1 Pickup Delay	2	0.00-600.00	=_____
Stage1 Curve type	Definite Time	Definite Time/Inverse Time	=_____
Stage1 Block Voltage	0	0-75 %Vn V	=_____
Stage1 Reset Delay	0	0.00-600.00	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Pickup	0.8 Vn	0.02-1.2 %Vn V	=_____
Stage2 Delay	2	0.00-600.00	=_____
Stage2 Curve type	Definite Time	Definite Time/Inverse Time	=_____
Stage2 Block Voltage	0	0-75 %Vn V	=_____
Stage2 Reset	0	0.00-600.00	=_____
Stage3 Function	Disable	Enable/Disable	=_____
Stage3 Pickup	0.8 Vn	0.02-1.2 %Vn V	=_____
Stage3 Delay	2	0.00-600.00	=_____
Stage3 Curve type	Definite Time	Definite Time/Inverse Time	=_____
Stage3 Block Voltage	0	0-75 %Vn V	=_____
Stage3 Reset	0	0.00-600.00	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Phase OverVoltage (59P)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Pickup	1.1 Vn	0.02-2 %Vn V	=_____
Stage1 Pickup Delay	2	0.00-600.00	=_____
Stage1 Curve type	Definite Time	Definite Time/Inverse Time	=_____
Stage1 Block Voltage	0	0-75 %Vn V	=_____

Parameters	Default Value	Range	Unit
Phase OverVoltage (59P)			**Continued…**
Stage1 Reset Delay	0	0.00-600.00	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Pickup	1.1 Vn	0.02-2 %Vn	=_____
Stage2 Delay	2	0.00-600.00	=_____
Stage2 Curve type	Definite Time	Definite Time/Inverse Time	=_____
Stage2 Block Voltage	0	0-75 %Vn V	=_____
Stage2 Reset	0	0.00-600.00	=_____
Stage3 Function	Disable	Enable/Disable	=_____
Stage3 Pickup	1.1 Vn	0.02-2 %Vn	=_____
Stage3 Delay	2	0.00-600.00	=_____
Stage3 Curve type	Definite Time	Definite Time/Inverse Time	=_____
Stage3 Block Voltage	0	0-75 %Vn V	=_____
Stage3 Reset	0	0.00-600.00	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Residual OverVoltage (59N)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Pickup	0.05 Vn	0.02-2 %Vn	=_____
Stage1 Pickup Delay	2	0.00-600.00	=_____
Stage1 Curve type	Definite Time	Definite Time/Inverse Time	=_____
Stage1 Block Voltage	0	0-75 %Vn	=_____
Stage1 Reset Delay	0	0.00-600.00	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Pickup	0.05 Vn	0.02-2 %Vn	=_____
Stage2 Delay	2	0.00-600.00	=_____
Stage2 Curve type	Definite Time	Definite Time/Inverse Time	=_____
Stage2 Block Voltage	0	0-75 %Vn V	=_____

Parameters	Default Value	Range	Unit
Residual OverVoltage (59N)			**Continued…**
Stage2 Reset	0	0.00-600.00	=_____
Stage3 Function	Disable	Enable/Disable	=_____
Stage3 Pickup	0.05 Vn	0.02-2 %Vn V	=_____
Stage3 Delay	2	0.00-600.00	=_____
Stage3 Curve type	Definite Time	Definite Time/Inverse Time	=_____
Stage3 Block Voltage	0	0-75 %Vn V	=_____
Stage3 Reset	0	0.00-600.00	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Sync Under Voltage (27S)			
Function	Disable	Enable/Disable	=_____
Stage1 Pickup	0.8 Vn	0.02□1.2 %Vn V	=_____
Stage1 Delay	2	0□600 Seconds	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25□80%	=_____
Sync OverVoltage (59S)			
Function	Disable	Enable/Disable	=_____
Stage1 Pickup	1.1 Vn	0.02-2 %Vn V	=_____
Stage1 Delay	2	0□600 Seconds	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25□80%	=_____

Directional Protections

Parameters	Default Value	Range	Unit
Directional Phase Instantaneous overcurrent (67PI)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Direction	Forward	Forward/Reverse	=_____
Stage1 Characteristic angle	-180	-180 to 180	=_____
Stage1 Voltage Polarisation	0	0-1.2	=_____
Stage1 Forward Pickup (*In)	0.1	0.1-20	=_____
Stage1 Reverse Pickup (*In)	0.1	0.1-20	=_____
Stage1 Forward Delay	0.00	0-600	=_____
Stage1 Reverse Delay	0.00	0-600	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Direction	Forward	Forward/Reverse	=_____
Stage2 Characteristic angle	-180	-180 to 180	=_____
Stage2 Voltage Polarisation	0	0-1.2	=_____
Stage2 Forward Pickup (*In)	0.1	0.1-20	=_____
Stage2 Reverse Pickup (*In)	0.1	0.1-20	=_____
Stage2 Forward Delay	0.00	0-600	=_____
Stage2 Reverse Delay	0.00	0-600	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Directional Phase Timed overcurrent (67PT)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Direction	Forward	Forward/Reverse	=_____
Stage1 Characteristic angle	-180	-180 to 180	=_____
Stage1 Voltage Polarisation	0	0-1.2	=_____
Stage1 Forward Pickup (*In)	0.1	0.1-20	=_____
Stage1 Reverse Pickup (*In)	0.1	0.1-20	=_____

Parameters	Default Value	Range	Unit
Stage1 Forward Curve type	IEC curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage1 Reverse Curve type	IEC curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage1 Forward TMS	0.00	0-600	=_____
Stage1 Reverse TMS	0.00	0-600	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Direction	Forward	Forward/Reverse	=_____
Stage2 Characteristic angle	-180	-180 to 180	=_____
Stage2 Voltage Polarisation	0	0-1.2	=_____
Stage2 Forward Pickup (*In)	0.1	0.1-20	=_____
Stage2 Reverse Pickup (*In)	0.1	0.1-20	=_____
Stage2 Forward Curve type	IEC curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage2 Reverse Curve type	IEC curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage2 Forward TMS	0.00	0-600	=_____
Stage2 Reverse TMS	0.00	0-600	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Directional Neutral Instantaneous overcurrent (67NI)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Direction	Forward	Forward/Reverse	=_____
Stage1 Characteristic angle	-90	-90 to 90	=_____
Stage1 Voltage Polarisation	0	0-1.2	=_____
Stage1 Forward Pickup (*In)	0.1	0.1-20	=_____
Stage1 Reverse Pickup (*In)	0.1	0.1-20	=_____

Parameters	Default Value	Range	Unit
Stage1 Forward Delay	0.00	0-600	=_____
Stage1 Reverse Delay	0.00	0-600	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Direction	Forward	Forward/Reverse	=_____
Stage2 Characteristic angle	-90	-90 to 90	=_____
Stage2 Voltage Polarisation	0	0-1.2	=_____
Stage2 Forward Pickup (*In)	0.1	0.1-20	=_____
Stage2 Reverse Pickup (*In)	0.1	0.1-20	=_____
Stage2 Forward Delay	0.00	0-600	=_____
Stage2 Reverse Delay	0.00	0-600	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Directional Neutral Timed overcurrent (67NT)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Direction	Forward	Forward/Reverse	=_____
Stage1 Characteristic angle	-90	-90 to 90	=_____
Stage1 Voltage Polarisation	0	0-1.2	=_____
Stage1 Forward Pickup (*In)	0.1	0.1-20	=_____
Stage1 Reverse Pickup (*In)	0.1	0.1-20	=_____
Stage1 Forward Curve type	IEC curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage1 Reverse Curve type	IEC curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage1 Forward TMS	0.00	0-600	=_____
Stage1 Reverse TMS	0.00	0-600	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Direction	Forward	Forward/Reverse	=_____
Stage2 Characteristic angle	-90	-90 to 90	=_____

Parameters	Default Value	Range	Unit
Stage2 Voltage Polarisation	0	0-1.2	=_____
Stage2 Forward Pickup (*In)	0.1	0.1-20	=_____
Stage2 Reverse Pickup (*In)	0.1	0.1-20	=_____
Stage2 Forward Curve type	IEC curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage2 Reverse Curve type	IEC curve A	IEC Type A,B,C IEEE Moderately Inverse, Extremely Inverse, Very Inverse	=_____
Stage2 Forward TMS	0.00	0-600	=_____
Stage2 Reverse TMS	0.00	0-600	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____

Frequency Based Protections

Parameters	Default Value	Range	Unit
Underfrequency (81U)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Pickup	49	20-70 Hz	=_____
Stage1 Delay	2	0-100	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Pickup	49	20-70 Hz	=_____
Stage2 Delay	2	0-100	=_____
Stage3 Function	Disable	Enable/Disable	=_____
Stage3 Pickup	49	20-70 Hz	=_____
Stage3 Delay	2	0-100	=_____
Stage4 Function	Disable	Enable/Disable	=_____
Stage4 Pickup	49	20-70 Hz	=_____
Stage4 Delay	2	0-100	=_____
Stage5 Function	Disable	Enable/Disable	=_____

Parameters	Default Value	Range	Unit
Stage5 Pickup	49	20-70 Hz	=_____
Stage5 Delay	2	0-100	=_____
Stage6 Function	Disable	Enable/Disable	=_____
Stage6 Pickup	49	20-70 Hz	=_____
Stage6 Delay	2	0-100	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____
Over frequency (81U)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Pickup	51	20-70 Hz	=_____
Stage1 Delay	2	0-100	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Pickup	51	20-70 Hz	=_____
Stage2 Delay	2	0-100	=_____
Stage3 Function	Disable	Enable/Disable	=_____
Stage3 Pickup	51	20-70 Hz	=_____
Stage3 Delay	2	0-100	=_____
Stage4 Function	Disable	Enable/Disable	=_____
Stage4 Pickup	51	20-70 Hz	=_____
Stage4 Delay	2	0-100	=_____
Stage5 Function	Disable	Enable/Disable	=_____
Stage5 Pickup	51	20-70 Hz	=_____
Stage5 Delay	2	0-100	=_____
Stage6 Function	Disable	Enable/Disable	=_____
Stage6 Pickup	51	20-70 Hz	=_____
Stage6 Delay	2	0-100	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____

Parameters	Default Value	Range	Unit
Frequency Gradient (81R)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Trend	Increasing	Increasing/Decreasing/Both	=_____
Stage1 Pickup (x In)	0.05	00.01-20.00	=_____
Stage1 OV Supervision (*Vn)	1.2	0.10-1.20	=_____
Stage1 Minimum	20	20-70	=_____
Stage1 Maximum	70	20-70	=_____
Stage1 Delay	2	0.00-100.00	=_____
Stage2 Function	Disable	Enable/Disable	=_____
Stage2 Trend	Increasing	Increasing/Decreasing/Both	=_____
Stage2 Pickup (x In)	0.05	00.01-20.00	=_____
Stage2 OV Supervision (*Vn)	1.2	0.10-1.20	=_____
Stage2 Minimum	20	20-70	=_____
Stage2 Maximum	70	20-70	=_____
Stage2 Delay	2	0.00-100.00	=_____
Stage3 Function	Disable	Enable/Disable	=_____
Stage3 Trend	Increasing	Increasing/Decreasing/Both	=_____
Stage3 Pickup (x In)	0.05	00.01-20.00	=_____
Stage3 OV Supervision (*Vn)	1.2	0.10-1.20	=_____
Stage3 Minimum	20	20-70	=_____
Stage3 Maximum	70	20-70	=_____
Stage3 Delay	2	0.00-100.00	=_____
Stage4 Function	Disable	Enable/Disable	=_____
Stage4 Trend	Increasing	Increasing/Decreasing/Both	=_____
Stage4 Pickup (x In)	0.05	00.01-20.00	=_____
Stage4 OV Supervision (*Vn)	1.2	0.10-1.20	=_____
Stage4 Minimum	20	20-70	=_____
Stage4 Maximum	70	20-70	=_____
Stage4 Delay	2	0.00-100.00	=_____

Parameters	Default Value	Range	Unit
Stage5 Function	Disable	Enable/Disable	=_____
Stage5 Trend	Increasing	Increasing/Decreasing/Both	=_____
Stage5 Pickup (x In)	0.05	00.01-20.00	=_____
Stage5 OV Supervision (*Vn)	1.2	0.10-1.20	=_____
Stage5 Minimum	20	20-70	=_____
Stage5 Maximum	70	20-70	=_____
Stage5 Delay	2	0.00-100.00	=_____
Stage6 Function	Disable	Enable/Disable	=_____
Stage6 Trend	Increasing	Increasing/Decreasing/Both	=_____
Stage6 Pickup (x In)	0.05	00.01-20.00	=_____
Stage6 OV Supervision (*Vn)	1.2	0.10-1.20	=_____
Stage6 Minimum	20	20-70	=_____
Stage6 Maximum	70	20-70	=_____
Stage6 Delay	2	0.00-100.00	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____

Power Based Protections

Parameters	Default Value	Range	Unit
Under/Over Power Protection (32P)			
Stage1 Function	Disable	Enable/Disable	=_____
Stage1 Under/Over	Under	Under/Over	=_____
Stage1 Pickup Parameter	W	W/VAR	=_____
Stage1 Pickup	0.3	0.20-1300.00	=_____
Stage1 Delay	2	0-600	=_____
Stage2 Function*	Disable	Enable/Disable	=_____
Stage2 Under/Over	Under	Under/Over	=_____
Stage2 Pickup Parameter	W	W/VAR	=_____

Stage2 Pickup	0.3	0.20-1300.00	=_____
Stage2 Delay	2	0-600	=_____
Alarm Function	Disable	Enable/Disable	=_____
Alarm (% Pickup)	80	25-80%	=_____

Reverse Power (32P)

Function	Disable	Enable/Disable	=_____
Pickup Parameter (W/VAR)	W	W/VAR	=_____
Pickup	0.3	0.20-1300.00	=_____
Delay	2	0-600	=_____

Lag Power Factor (55)

Function	Disable	Enable/Disable	=_____
Pickup	0.95	0.05-0.95	=_____
Delay	2	1-240	=_____
Alarm Pickup	0.95	0.05-0.95	=_____
Alarm Delay	1	1-240	=_____

Lead Power Factor (55)

Function	Disable	Enable/Disable	=_____
Pickup	0.95	0.05-0.95	=_____
Delay	2	1-240	=_____
Alarm Pickup	0.95	0.05-0.95	=_____
Alarm Delay	1	1-240	=_____

Chapter 9

User Interface

Overview

This section provides a detailed description of local interfacing methods available with FCOMP Relay to update the all the protection, system settings etc. as well as metering and monitoring. Two local human machine interface options are available in the FCOMP relay as follows

- Front Panel
- COMPfigurator™ Software

Front Panel

Front panel of the relay provides advanced user friendly navigation technique. It includes of Liquid Crystal Display (LCD), Numeric Keypad, control Pushbuttons, LED indicators and USB 2.0 port for communication Modbus serial protocol with COMPfigurator™ software.

Key points:

- Quick access to all the functions
- Password protected access to display
- Measurement of all electrical parameters
- Updating of system and protection setting
- Monitor Status of the digital Input/output
- Quick message of trip through LED indication and Display pop-up.
- Monitor event trip records & disturbance records
- Single line diagram, Phasor diagram as default screens

Overlay Design

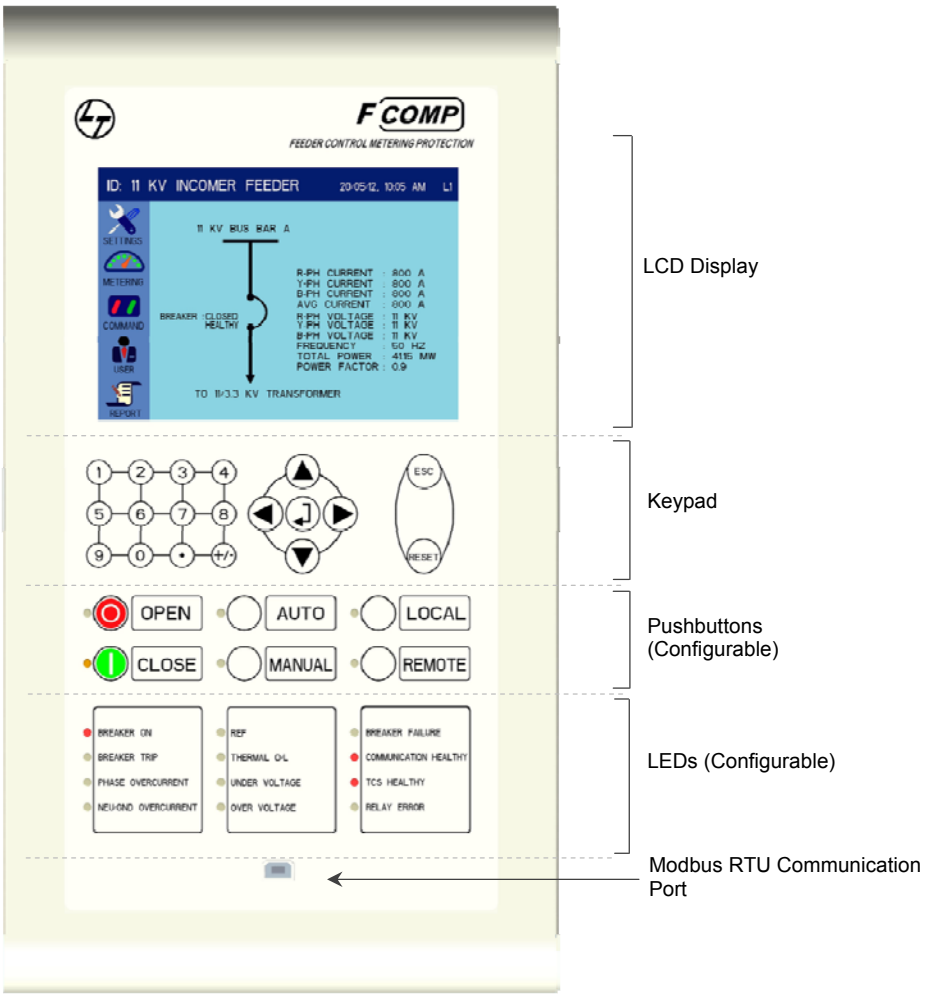


Figure 9-1: Front Panel

Figure 9-1 divides relay front panel into five different areas as follows.

LCD Display: 5'' thin film transistor multicolor liquid crystal display (TFT LCD) with high resolution for configuration and monitoring of the system in a sigle view.

Keypad: consists of numerical keypad & navigation keys for easy access to read and write the data values of functions provided.

Numeric Keypad – a 12 buttons keypad comprising of 0 to 9 digits and decimal point to enter any decimal value.

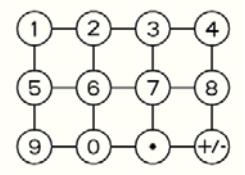


Figure 9-2: Numeric Keypad

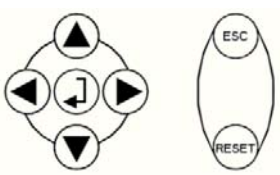


Figure 9-3: Navigation Keypad

Navigation keys -These keys can be used to navigate between the menus.

The function of navigation keys are listed in the table 9-1

Table 9-1: Functions of navigation keys

Keys	Symbol	Function
Up		To move up in menus display. To increment the value of selected option by predefined step of value.
Down		To move down in menus display. To decrement the value of selected option by predefined step of value.
Left		To move left or the previous option.
Right		To move right or the next option.
Enter		To enter into particular menu and to edit value of function.
Escape	ESC	To exit from the selected menu window to the earlier screen.
Reset	RST	To reset the data values of the selected display window.

Pushbuttons: Six pushbuttons are provided on the front panel that can be configured by the user to perform different functions as per his requirements, through COMPlogicTM software. These pushbuttons can be used for functions like to Trip/close breaker contact, local/remote operations, etc. Whenever the pushbuttons are programmed, it is required to insert print label describing the function of the pushbutton for which it is assigned. LEDs are provided alongwith the pushbuttons to check the status of the assigned functionality.

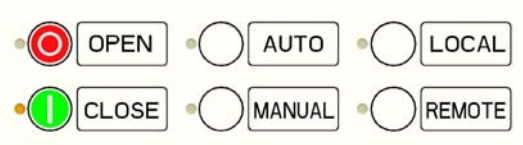


Figure 9-4: Pushbuttons

LED Indicators: Relay gives quick message for Relay pickup/alarm/trip, DI status and status of any other bits through sigle color LED indicators. Twelve reprogrammable LED's can be configured through COMPlogicTM in the COMPfigurator software.

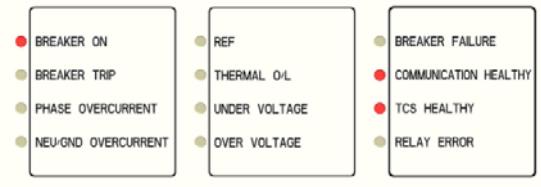


Figure 9-5: LED Indicators

Communication Port: USB 2.0 port on modbus RTU protocol is provided for the local communication of Relay with COMPfigurator™ software. For Modbus connection, communication parameters such as baud rate, parity, stop bit etc. must be matching. The speed of the communication is limited to the range of 300 to 38400 bps.

Display Menu navigation

When Relay is energised by power supply, L&t Logo screen will be displayed followed by the main screen with iconic view of following menus for quick navigation.

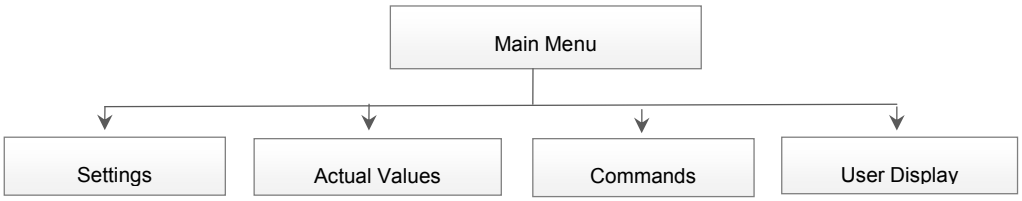


Figure 9-6: Main menu navigation

On display to get into a particular Menu, user must use the ENTER button; to go back to the previous Menu, the Escape button can be utilised. The Arrow buttons are used for navigation between all available options. By using the numerical keypad, user can enter the data values such as pickup value of selected parameter, delay time, nominal value, etc.

The top bar indicates, date and time, User access level and user editable text describing for which feeder the relay is used.

Settings

The setting flow chart shown in fig 9-7 with all read write type of settings.

Product Settings

- User Access Level - Relay is provided with three user levels L1 (User), L2 (Supervisor), L3 (Administrator). L1 access is by default having only read settings, user not allowed to change any settings. Access to L2 and L3 is password protected with both read write rights. (There will be automatic changeover from L2/L3 to L1, if navigation is not done for more than 10 mins)
- Communication settings – Default settings for modbus, profibus, IEC61850 are mentioned in setting sheet
- Set Date and time of RTC.

System Settings

- CT/VT Ratio – Settings for Primary and secondary values of current and phase to neutral voltage. The secondary value of current and voltage is taken as nominal current and nominal voltage for all protections.
- DI voltage level – Voltage selection for digital inputs as per the control supply used.

Protection Elements

- Four different groups of protections settings are provided with different stages of protections.
- More than one stage from same group can be kept enable, but only one group is available at a time.
- The settings for all current based, voltage based and directional protections can be entered.

Control Elements

- Setting group – Defining which protection group is enabled.
- Settings for control protections such as cold load pickup, second harmonic blocking and auto recloser.

Monitoring Elements

- Settings for monitoring elements such as breaker failure, VT fuse fail, Synchrocheck and CT supervision.

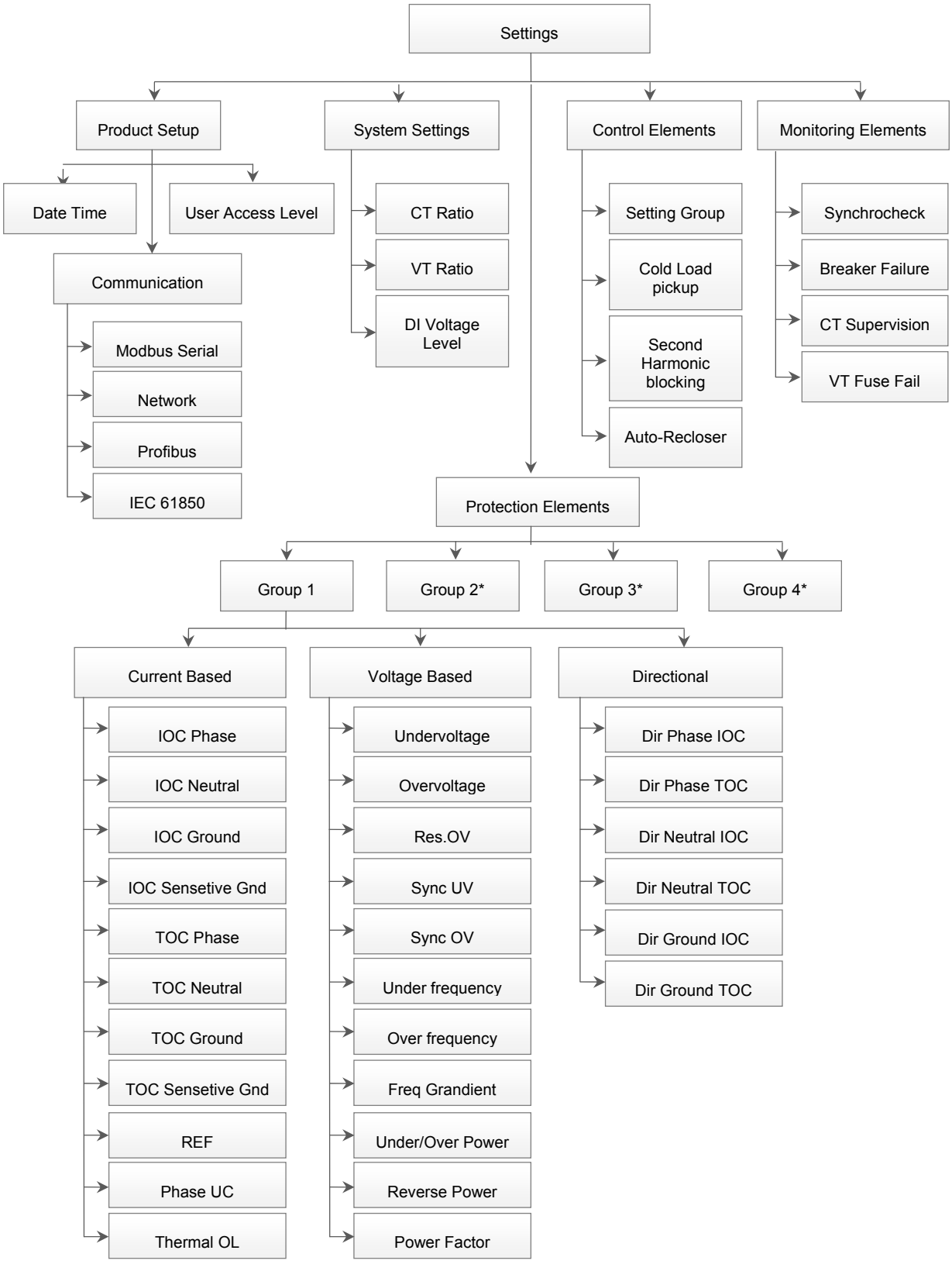


Figure 9-7 Settings Navigation Chart

Actual Values

Actual Value flowchart is shown in fig 9-10 with all readable parameters.

Status

- ON/ OFF status of digital inputs and open /close status of digital outputs of CPU card and Add-On cards are displayed.
- Green color represents ON/Close while red color represents OFF/Open.
- Card B- CPU card DIDOs
- Card D/E/F : Add-On card DIDOs

Metering

- Current Metering – Measurements of magnitude and phase angle of fundamental, RMS, maximum value of 3 phase currents, Neutral and ground currents, symmetrical components and average current are displayed in single screen.
- Voltage Metering – Measurements of magnitude and phase angle of fundamental, RMS, maximum value of 3 phase to neutral and phase to phase voltages, Residual Voltage, symmetrical components, frequency and average voltage are displayed in single screen.
- Power/ Energy – Measurements of Active, reactive and apperent power and energy.
- Demand – Measurement of continuous load on the system and peak demand in terms of current and voltages.
- THD- Measurements of individual harmonic distortion in percentage upto 25th harmonic as well as total harmonic distortion

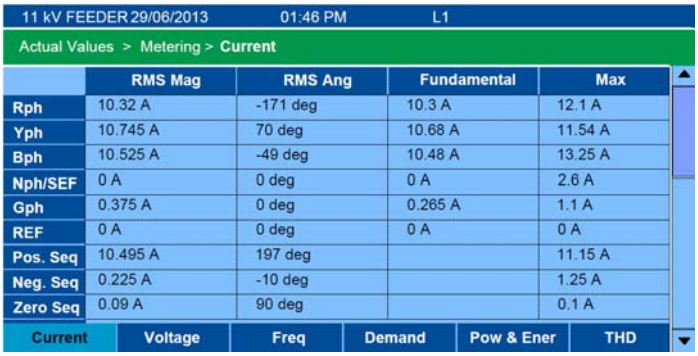


Figure 9-8: Metering screen

Event Records

- Summery sheet of last 20 events recorded by the relay.
- Detailed report (Cause, Date time, Data on 8 user selectable parameters) of each record is provided when we select the perticulat event.

Figure 9-9: Event log summery

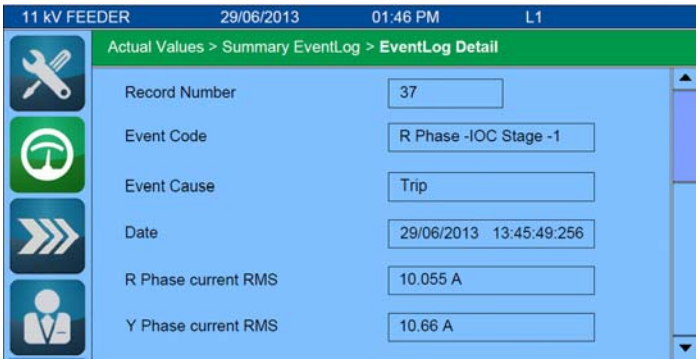


Figure 9-10 Event log detailed view

Hour meter

- Displays time period for which feeder is in operation.

Product Info

- Information about card varients available in the relay.
- Information about firmware version present in the relay.

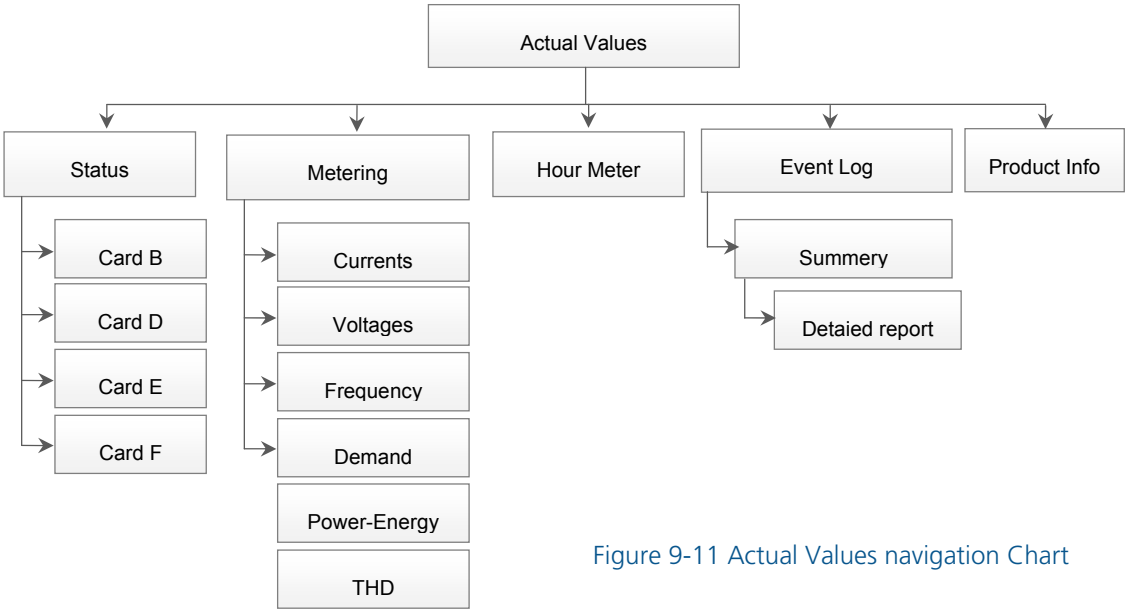


Figure 9-11 Actual Values navigation Chart

Commands

Commands to clear different data records stored in the relay such as event reports, oscillographic record, maximum metering values etc.

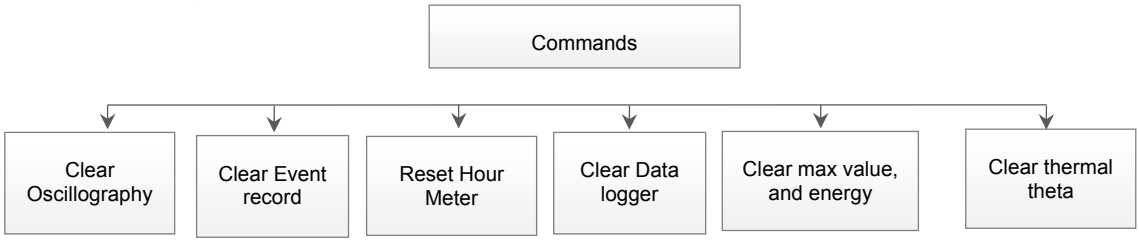


Figure 9-12 Commands navigation Chart

User Display

There are four different monitoring screens are available as-

Phasor Diagram – Current and voltage phasors with R- phase voltage as a reference phasor.

Single line Diagram – SLD showing Breaker ON/OFF status with information about on which feeder relay is used, voltage level of the feeder and current and voltage metering value.

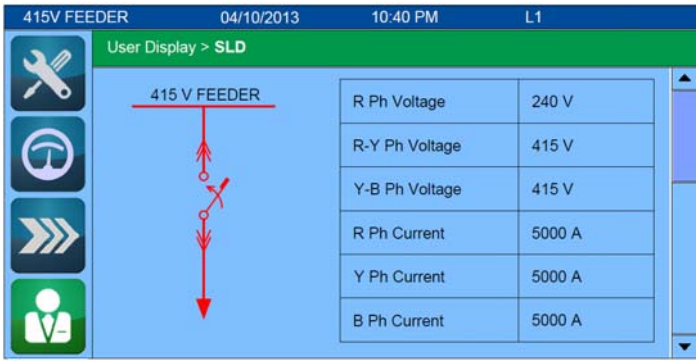


Figure 9-13 Single Line Diagram

Annunciator – Indicates status of 12 user configurable parameters such as protection trip alarm pickup bits, DI status etc.

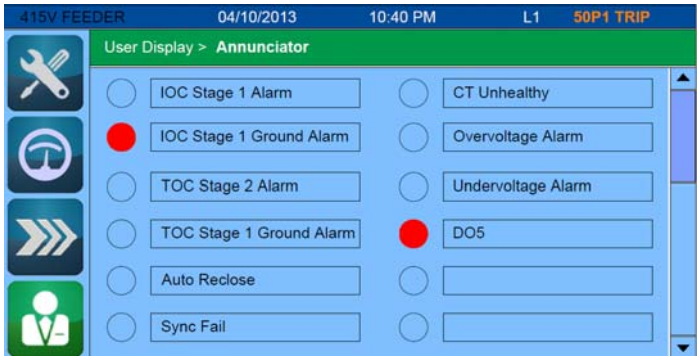


Figure 9-14 Annunciator screen

Oscillography – Wave nature of 8 user- selectable parameters of last recorded fault in the system.

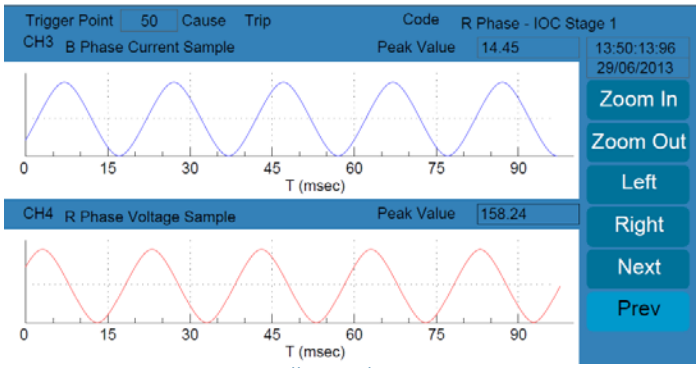


Figure 9-15 Oscillography Screen

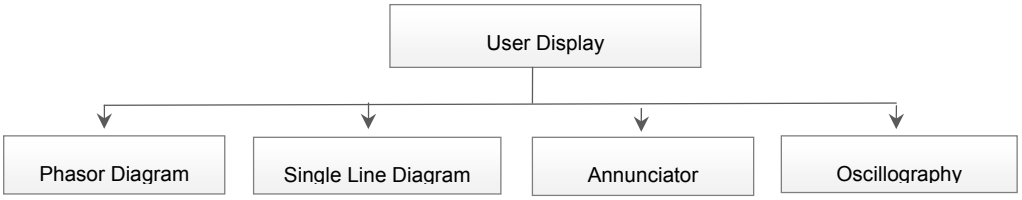


Figure 9-16 User Display navigation Chart

COMPfigurator™

COMPfigurator™ is the PC HMI software of L&T relay which provides flexibility to configure, monitor and troubleshoot the relay operations in online (Relay connected to PC) as well as in offline mode (relay disconnected) modes.

Key Points –

- User friendly parameterisation
- Quick access to all the functions and protection settings
- Password protected access to software
- Online monitoring of parameters
- Monitor Status of the digital Input/Output
- Quick message of trip through pop-up.
- Monitor event trip records, Oscillographic records and data recorder
- Designing of control logic with drag-drop technolodgy
- Offline saving of setting files

Software Pre-requisites:

- Operating Systems: Windows XP/Vista/7/8.
- Microsoft .NET Framework 4.0 Service Pack 3
- Windows Installer 4.5

Hardware Pre-requisites:

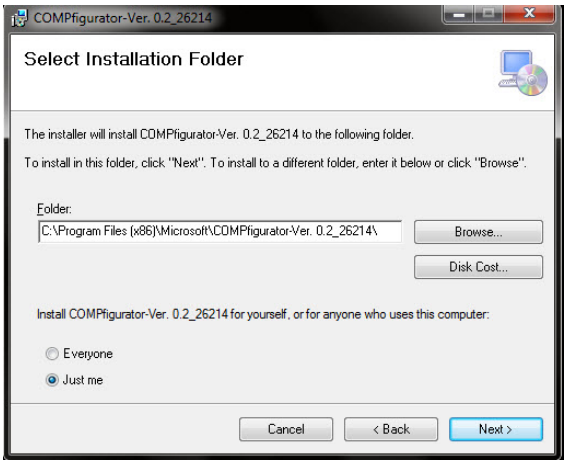
- Minimum hard disk space 500MB.
- Processor: 1 GB RAM with 1 GHz speed.
- Ethernet interface.

Installation Guide

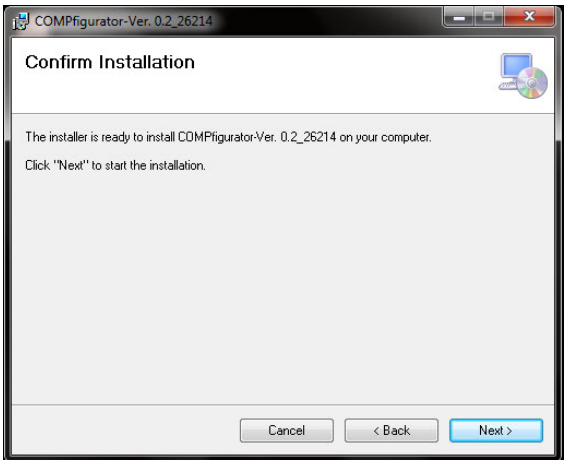
COMPfigurator™ Installation

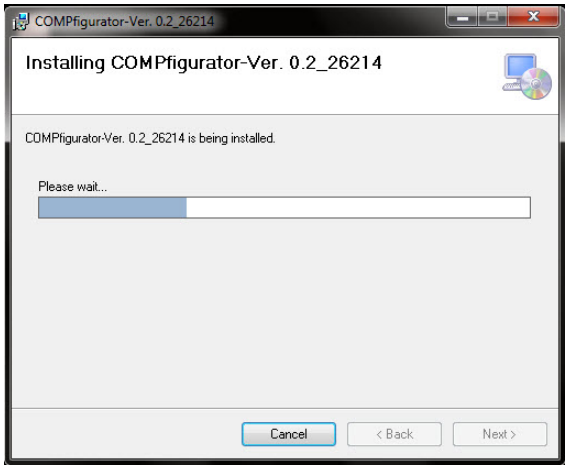
1. To install COMPfigurator™, apply the following procedure:
2. Double-click on COMPfigurator™ setup file.
3. Click on 'Next' button to start installation.

4. Choose the installation folder path to install setup and select user access level. Click on 'Next' button to proceed further.



5. Once the license agreement is accepted by the user, Windows will automatically start installing the setup. The progress of the installation can be tracked at the Status bar.





6. When the installation is completed, press Close button to finish the setup. This will create a shortcut icon for COMPfigurator™, COMPlogicTM and oscillography on the desktop of the user.

Operational Guide

Access to COMPfigurator™ main window

1. Double-click on the COMPfigurator™ short-cut icon to launch the application.

2. Offline window of the program will appear on screen as follows.

Figure 9-17 Configurator Main window

3. Click on 'Mode' menu from menu bar and select online window. The user can change protection settings in the offline window also.

To connect Device

1. To connect Relay device to the PC, click on 'Connect' icon from main window tool bar. The setup window will appear.

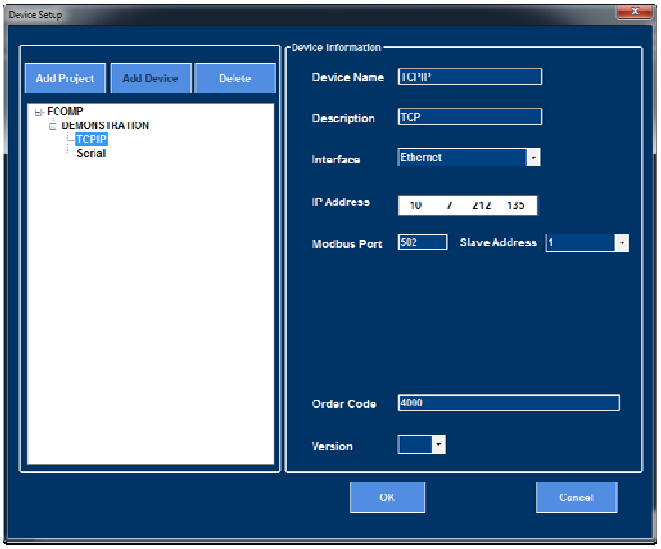
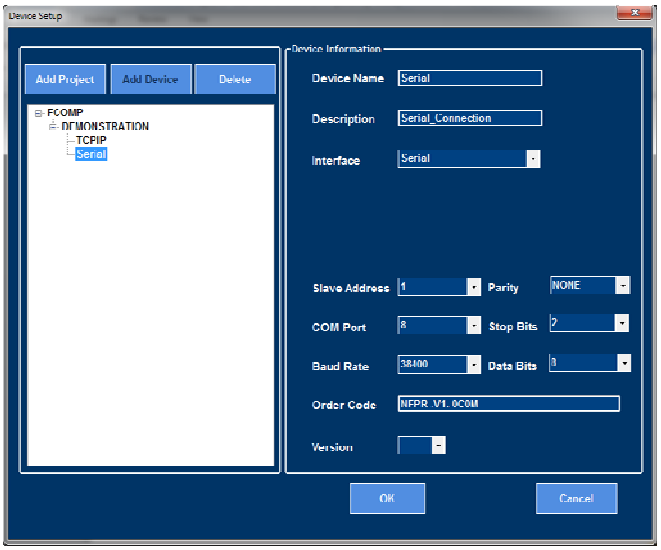
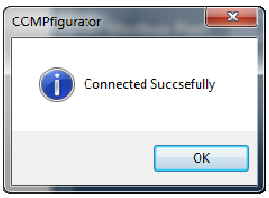


Figure 9-18 Communication Settings

2. Select Serial or TCPIP Protocol as per the communication cable connected.
3. Default TCP/IP Address: 10.7.212.135
4. Select proper communication port in case of serial communication. Match the other properties such as baud rate, parity, stop bits etc.



5. Click 'OK' to proceed further. Message will be displayed on successful communication.



6. User need to login to get access to configure the relay. There are three user access levels administrator, Supervisor and user. Administrator will have all read/write access. The user access level and supervisor access level will have rights which are defined by administrator.

Figure 9-19 Login Window

7. After successful login, the main configuration window will appear on screen as shown below with options to configure and monitor the relay.

Figure 9-20 Online Window

To configure the relay

There are 3 options available to configure the relay.

1. **Product Settings** : It includes basic settings as mentioned below –
    - Date and time – Time synchronization with SNTP server
    - Demand – Methods to calculate demand.
    - Single line diagram – Selection of text and six electrical parameters which are displayed on SLD screen.
    - Communication settings - Modbus serial, Modbus TCP/IP, Profibus, IEC 61850 communication protocols.
    - Clear Relay Records – Commands to clear stored data in relay and to reset the relay

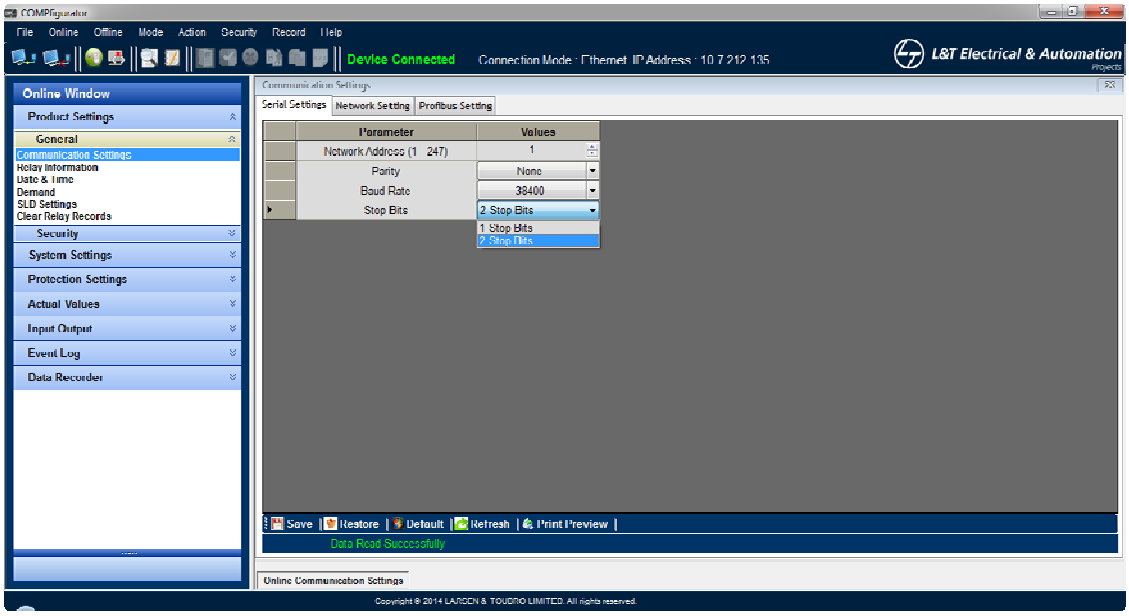


Figure 9-21 Product Setup

2. **System Settings:** It includes all the system settings in which relay are connected.
    - Current – CT Primary and secondary
    - Voltage – VT Primary and secondary, Connection type
    - Setting groups – Defined which group is enabled if one or more group is enabled at the same time it takes the settings of group which comes first by numerical order. Option control equation indicates that protection group changeover is defined by designed gate logic through COMPlogicTM.
    - User defined memory map – It gives flexibility to directly access only required monitoring data in SCADA/DCS communication.

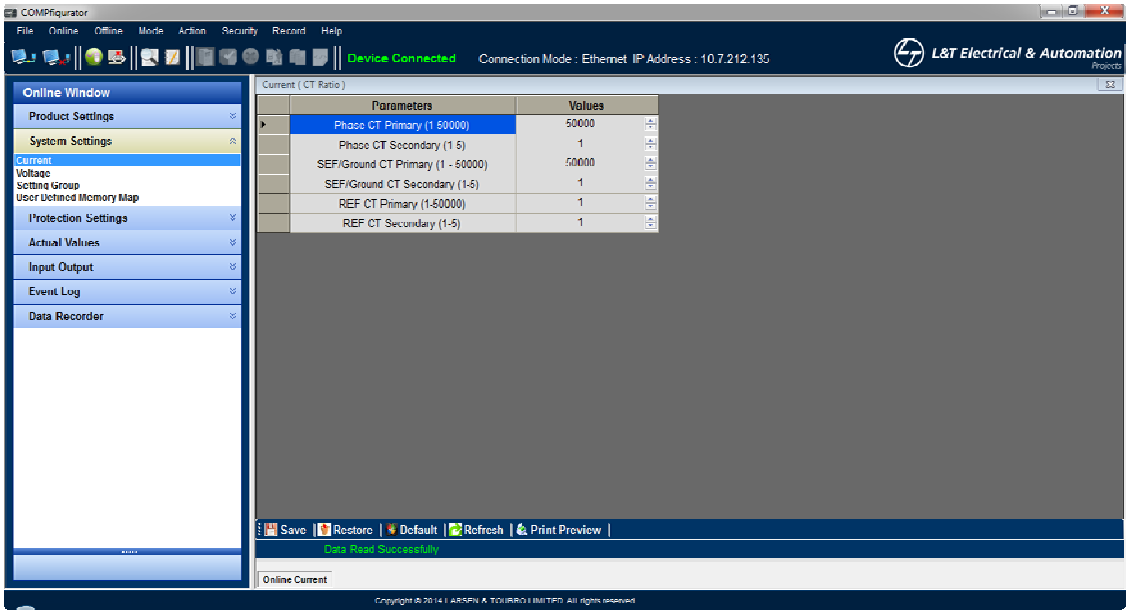


Figure 9-22 System Settings Window

3. **Protection Settings:** All feeder protections are included.

   - Each of four groups include same no of current, voltage, frequency and power based protections with number of stages in each protection.
   - Any one group will be enabled at a time, but more than one stage can be possible to enable with different pickup level and delay.
   - To download the settings into relay in online mode click on save tab situated on toolbar at bottom of the each protection window.
   - User can able to restore original settings or can able to set default settings as per the setting sheet.

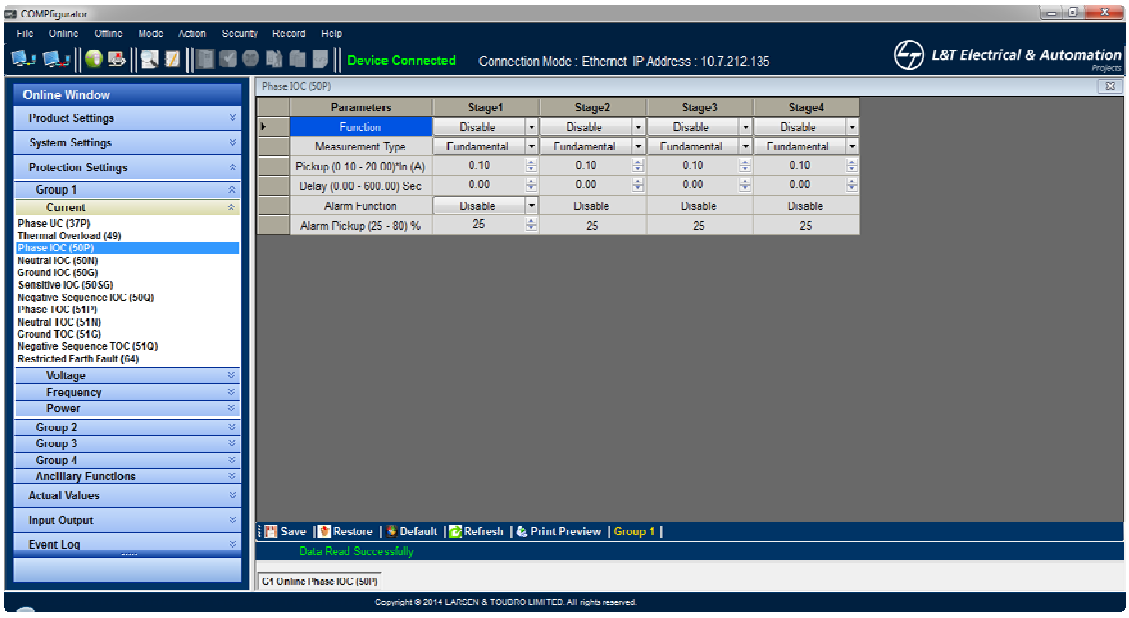


Figure 9-24 Protections Settings Window 2

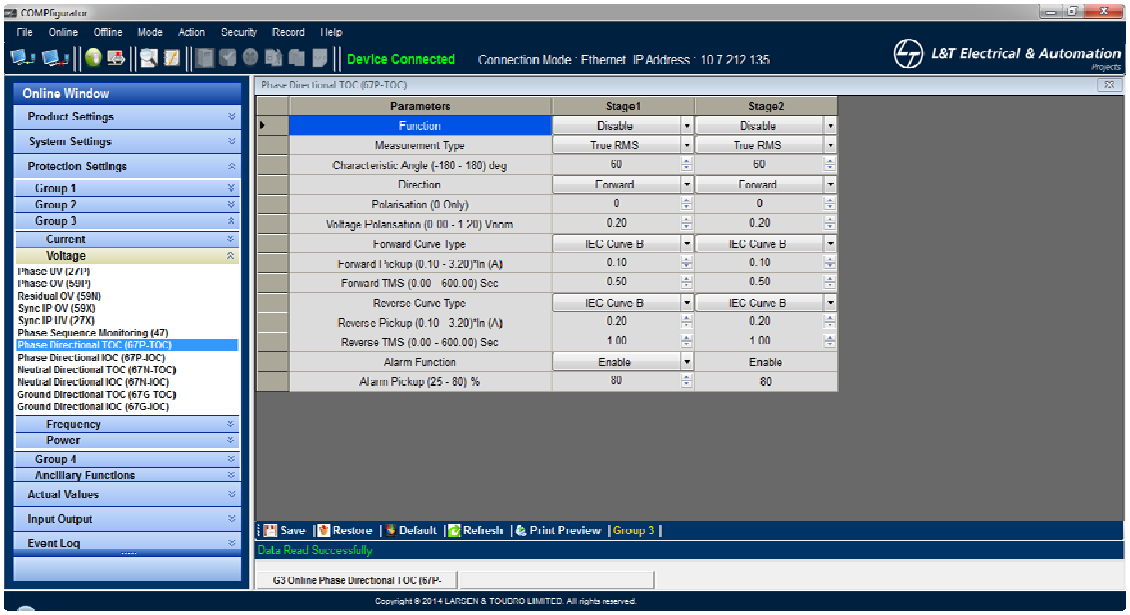


Figure 9-25 Protections Settings Window 3

To monitor the relay

Actual Values : It displays the metering data of all the electrical parameters as stated in measurement chapter.

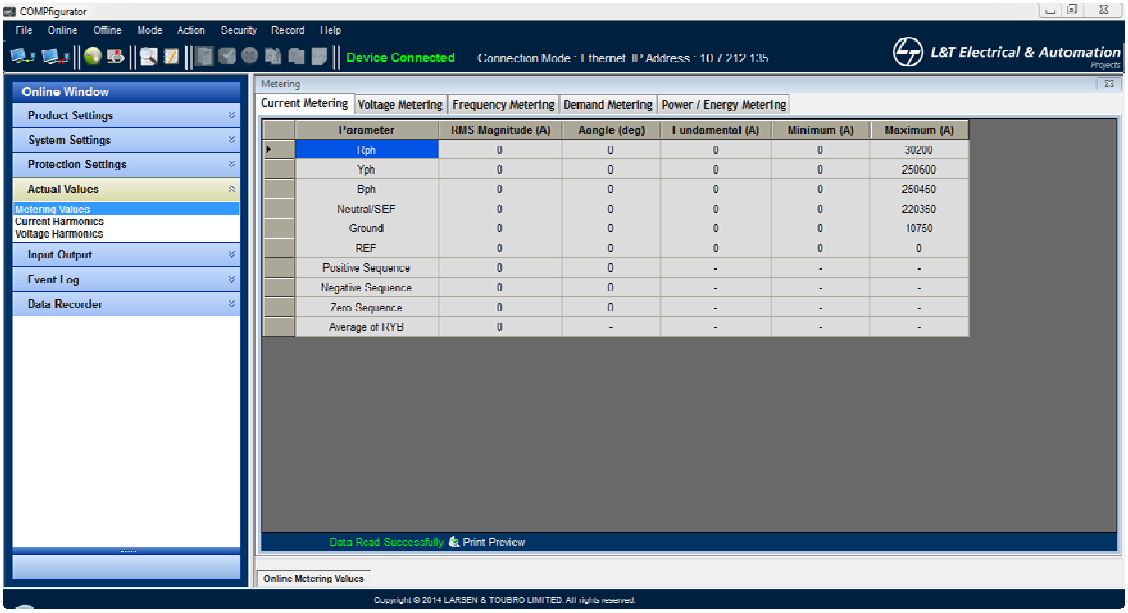


Figure 9-26 Actual Values Window

Input output: Defines voltage level of all the Digital inputs as well as gives the status of each digital input and output. Green color indicates that Digital input is high/ Digital output is closed while red color indicates that Digital input is low/ Digital output is opened.

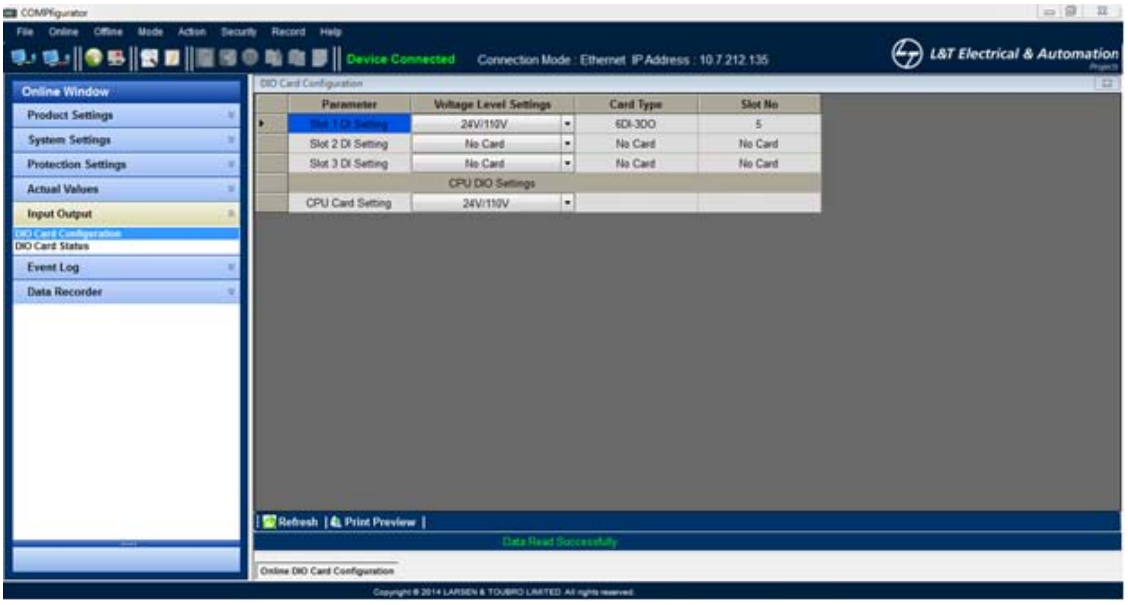


Figure 9-27 Input Output Window

Event Log:

- Selection of channels (electrical parameters) whose status will be displayed in detailed view of event report.
- Parameter selection – which event should be captured by the relay.
- View event log – displays summery and detailed report of events recorded after fetching the events from the relay.

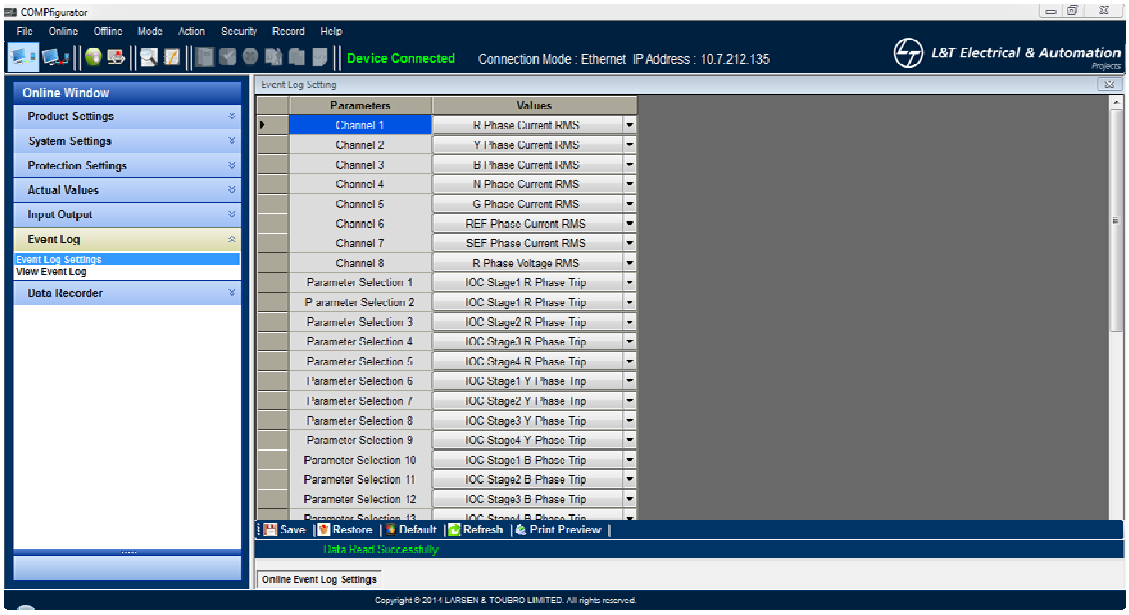


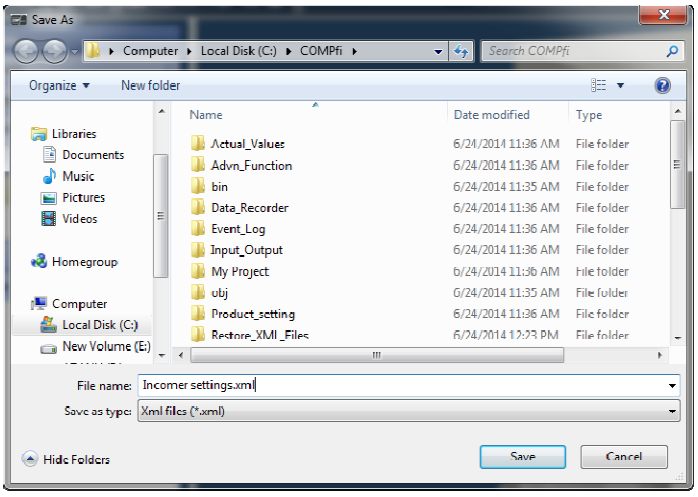
Figure 9-28 Event Log setting Window

To create backup of the settings

1. Select ‘Export existing device settings’ from online menu.

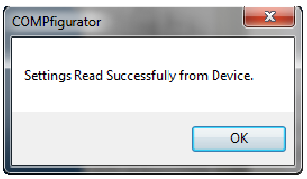
Figure 9-29 Online Backup of settings

2. Save the file in .xml format in destination folder.



3. It will read all the data from the relay and create backup file.

4. Completion message will be displayed on the screen after successful backup.



To create new user

1. Click on 'Security' tab and select 'Add user'.
2. Define username and password under proper user group.

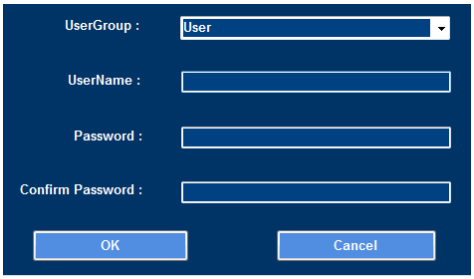


Figure 9-30 Create new user Window

3. Provide rights to respective user through 'configure user' option.

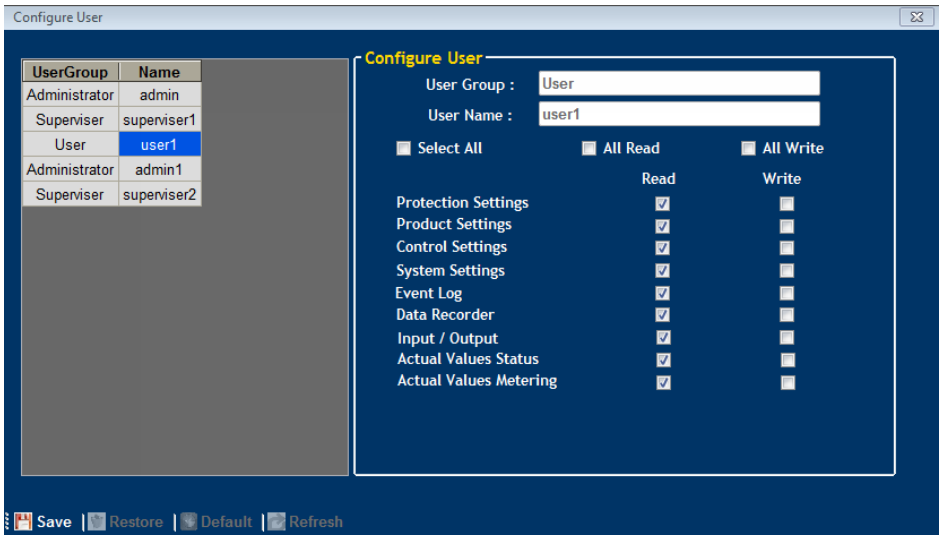
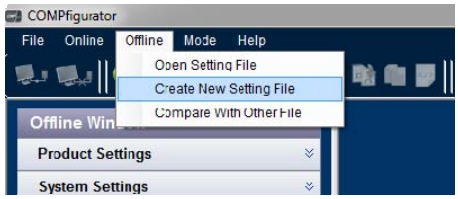


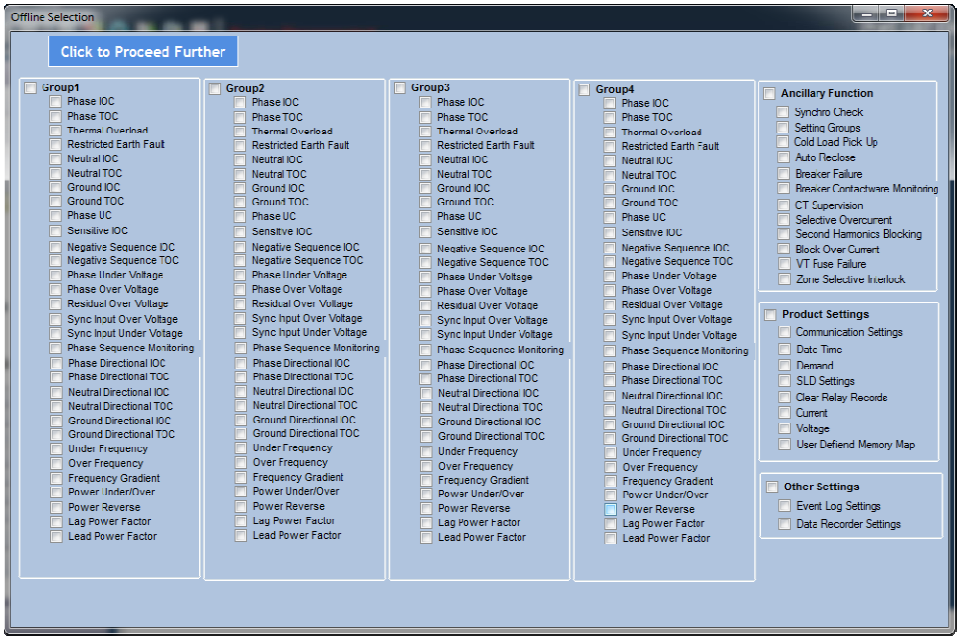
Figure 9-31 User access configuration Window

To create configuration file in offline mode

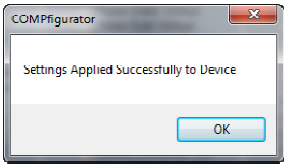
1. Click Offline option from menu bar.
2. Select Create New setting File. This option will create new setting file with all protection settings, system settings and product setting. User can able to open existing setting file as well as able to compare the file with another saved file.

i. 

3. Save all the individual settings as per the configuration required. Individual setting files will be automatically saved into master file at the time of clicking save tab.
4. To download all the settings into the relay, select icon download to relay from toolbar. Below selection window will appear.



5. Select the protections which user wants to download into relay.
6. Whenever download is completed, completion message and status will be displayed on screen.



COMPlogicTM

This application provides flexibility to the user to design the programmable logic with drag and drop technolodgy using different input and output elements (operands) with basic AND, OR and NOT gates (operators) alongwith timers, Latches and counters. The user can design any complex logic with more than 80 no. of operators which can be processed sequentially. The basic advantage of designing program logic is to reduce the hardwiring of the switchboards.

To communicate relay with COMPlogicTM

1. Double click on COMPlogicTM icon from desktop. Main window will appear.

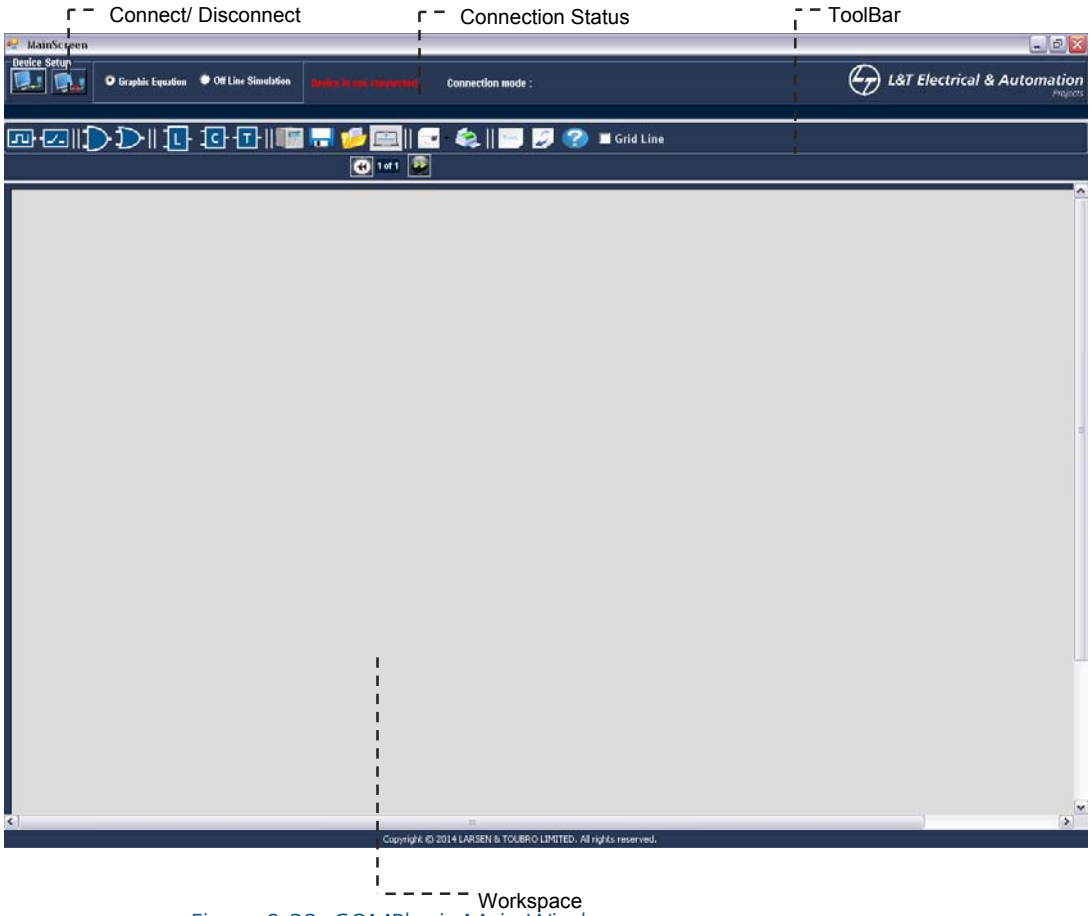


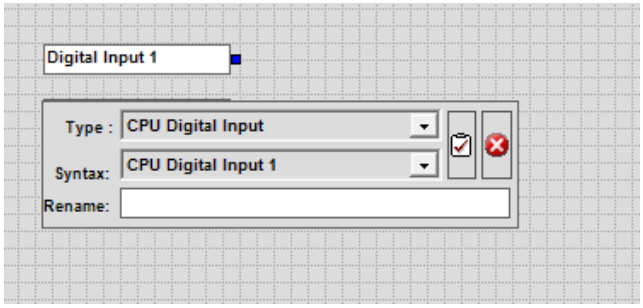
Figure 9-32: COMPlogic Main Window

2. Click on 'Connect' icon. The following window will appear showing communication options.

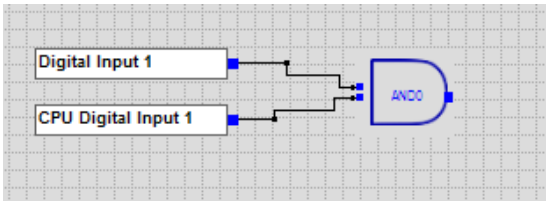
3. Select the configuration as per the comunication protocol selected.
4. Proceed by clicking ‘connect’ tab.

To Design logic as per scheme

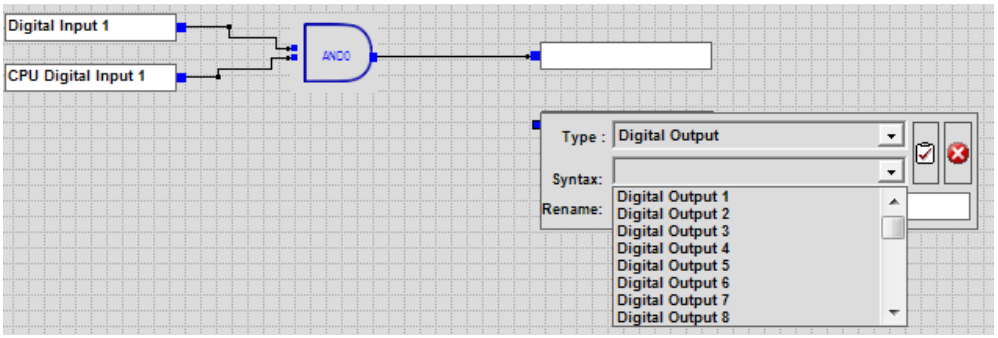
1. Click on input button from toolbar. Now click on are on workspace where the input need to be placed. Double click on the input to select its properties.
2. Type and Syntax defines the exact type of the input selected



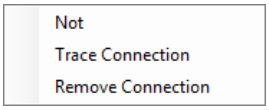
3. Click on gate (AND/OR) then click on workspace available. Now to join input and gate through link first click on the blue point then second click on gate. Links will be added as follow.

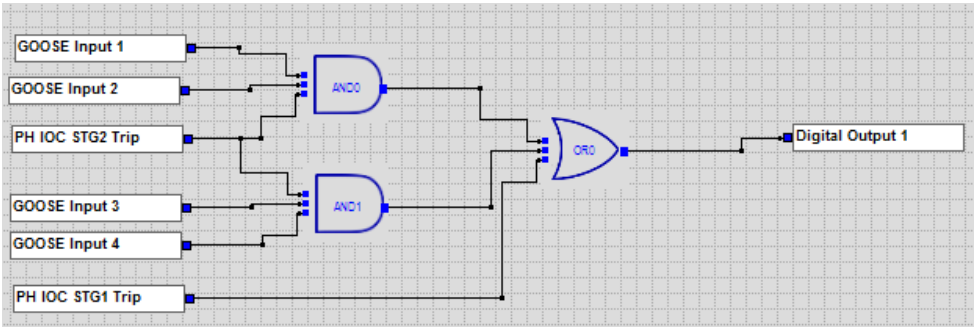


4. Select output same as input and provide a link. User can define the text for the inputs/Outputs also as per the electrical scheme.



5. To add not gate in particular path, right click on the end point of the link and select ‘Not’ gate. User can remove link or able to trace connection with options provided.





To add Latch/timer/counter click on the latch icon, then click in workspace where Latch, counter or timer need to be placed. Double click on the Latch/timer/counter to set properties.

Timers - There are 32 timers are provided. Each timer can be operated in two modes – Pickup mode and Drop Out mode. The timer starts counting when the external input is HIGH and sets an Operate bit HIGH after the specified delay, only if the external input is continuously HIGH during the delay period. If the external input goes LOW before the Operate bit is set HIGH, the timer is reset.

Timer Settings: Timer mode defines the unit for the delay value held in Pickup/Drop out Delay registers.

Type 0: Millisecond

Type 1: Second

Type 2: Minute

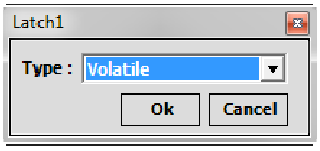
Delay: Holds the delay value for the Timer when it is operated pickup/dropout mode.

Latch – There are 32 latches are provided. The Set & Reset input of the latch can be mapped into any two inputs. The operation of latch is as follows.

Set	Reset	Output
0 0		Last State
0 1		0
1 0		1
1 1		Last state

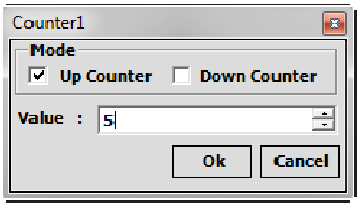
Volatile - Latch output state will not retained after Power recycle of relay.

Non-Volatile - Latch output state will retained after Power recycle of relay.



Counters – There are 32 Counters have been provided. Each counter can be operated in two different modes: Up mode & Down mode. Each counter can be configured to respond to any input.

The counter counts the number of LOW to HIGH transitions of the external input and sets an Operate bit HIGH when count has reached a pre-specified value.



Count value: Holds the maximum value for the counter when the counter is operated in up mode.

Preset Value: Holds the Starting count for the counter when it is operated in down mode.

Similar way one can design any complex logic with the help of number of gates.

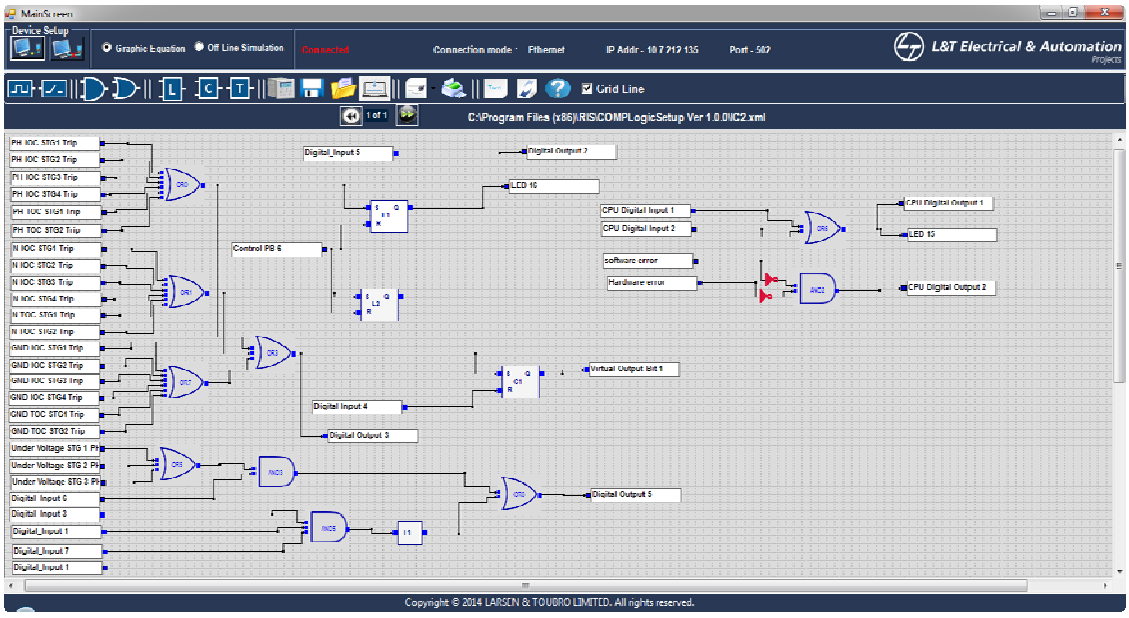
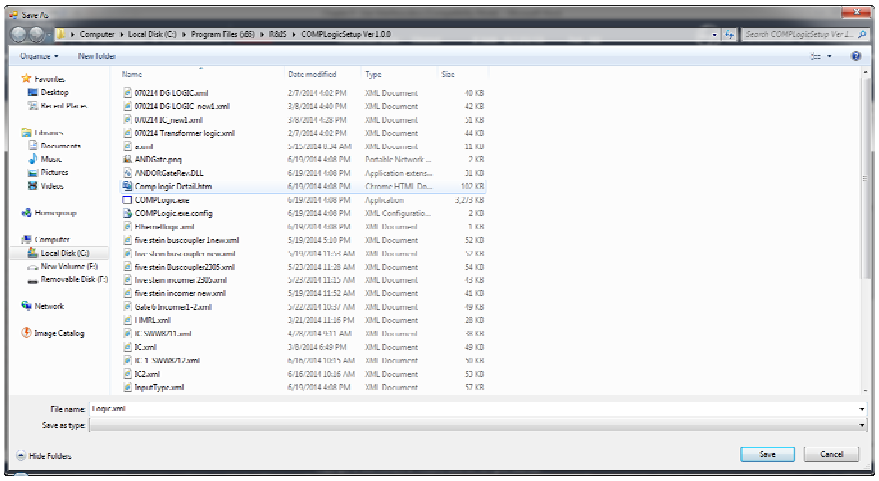


Figure 9-33 Logic designed in COMPlogic

To save the file

1. Click on save icon. Save the file into .xml format



Offline simulation:

1. User can verify the logic by using concept of offline simulation.
2. Click on 'offline simulation'; open the saved .xml logic file.
3. Double click on any input it will trace the complete path of the operation of the input.

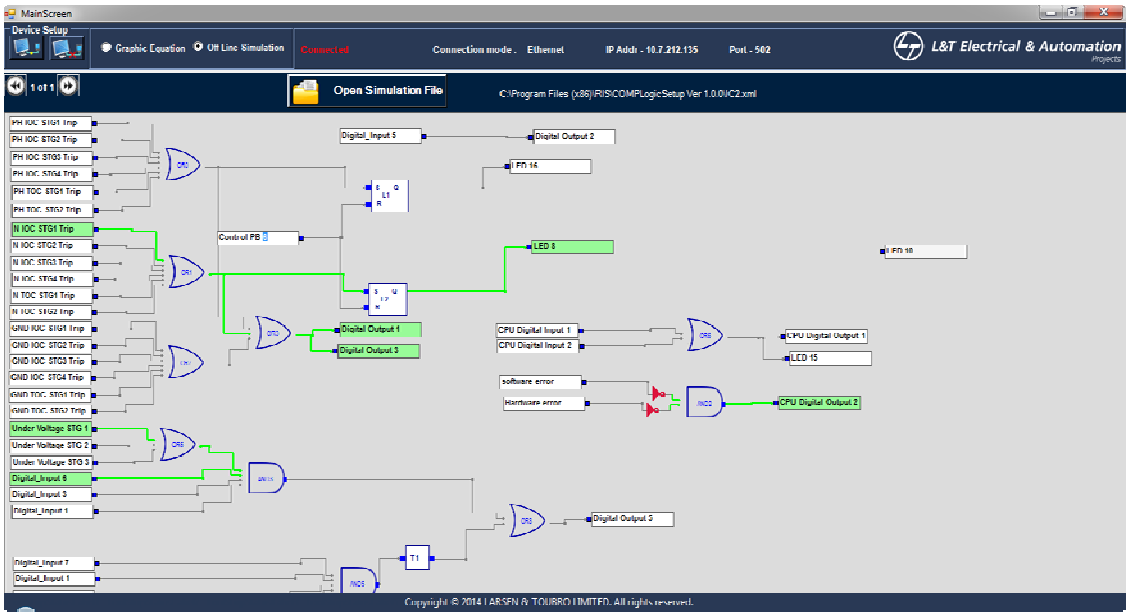
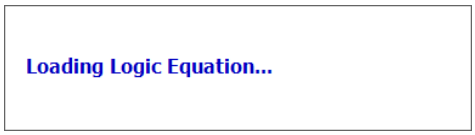


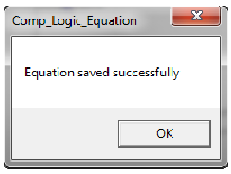
Figure 9-34 Offline Simulation

To download equation into relay

1. Click 'Download to relay' icon. Equation will get automatically downloaded into the relay.



2. After completion of download, message will be displayed.



Oscillography

Oscillography records contain waveforms captured at the predefined sampling rate as well as other preset Relay data at the point of trigger. Sample per cycle and no. of cycles are user selectable.User can defined a trigger point with the help of prefault and post fault division of the wave in terms of number of cycles.

To communicate relay with COMPlogicTM

1. Double click on oscillography icon from desktop. The main screen will apear as follows.
2. Click on 'Connect' icon. The following window will appear showing communication options.

3. Select the configuration as per the comunication protocol selected.
4. Proceed by clicking 'connect' tab.
5. After establishing connection, click on setting tab to select the events for which oscillography should trigger and channel. Number of cycles and number of samples per cycle are can be also configured.

- - - - -

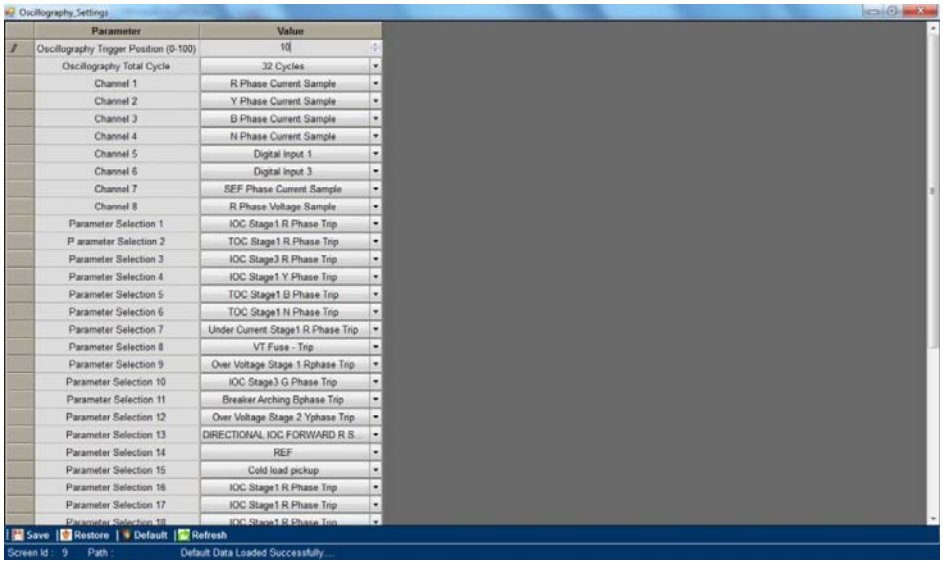


Figure 9-35 Oscillography Setting

6. Click on fetch oscillography button to fetch all 64 records from the relay.
7. Select the record and proceed with show record, following window will open. With the waveform one can able to analyse the nature of the fault.

Chapter 10

Testing & Troubleshooting

Overview

This section allows the user to acknowledge and troubleshoot any problems encountered during testing and commissioning of Relay. A complete functional check and calibration has been performed in each unit before it is shipped. This helps to ensure that received Relay unit is fully functional or not. Commissioning tests confirm that the Relay is properly installed and logically working fine.

Relay Testing

The following connection tests help to enter settings into the Relay and verify that the Relay is properly connected or not. Brief functional tests ensure that the Relay settings are correct. Modify the procedure as necessary to conform to your standard practices. You need not repeat it unless major changes are made to the Relay electrical connections.

Functional Testing

Functional test is performed by the Larsen & Toubro to ensure that the Relay is properly functioning before site installation or can be done by the customer for validation during commissioning activities.

Measurements & Accuracy

Phase current

Connect R-Y-B phases and neutral current cables of testing kit to CT connector of relay.

- Inject balanced/Unbalanced currents on the three phase CTs of Relay.
- Observe the current magnitude & angle in all phases and neutral, compare with the expected metering by taking CT ratio into consideration. Current in neutral metering should be zero in case of balanced system.

Voltage

Connect R-Y-B phases and neutral Voltage cables of testing kit to VT connector of relay.

- Set the magnitude & phase angles of the voltage.
- Observe the voltage metering on the display. Compare the values of phase to neutral as well as phase to phase voltages with the injected voltage considering PT ratio.
- Measure the frequency of the system.

Power & Power factor

Connect both current as well as voltage source to the Relay.

- Set the magnitude of the voltage and current. Connect voltage in star or delta connection.
- Observe the Real, Reactive & Apparent power metering values on the display and compare them with the expected values by taking CT & PT ratio into consideration.
- Observe Power factor depending on angle difference of current and voltage phasor.

Protection Testing

Perform following test by enabling the particular protection

Table 10-1: Basic protections testing

Protection	Settings	Applied Input	Expected Result	Observations
50P	Pickup = 1.00* In Delay = 1.2 Sec	I = 1.2 A (Any one of phase)	Trip after 1.2 sec	
50N	Pickup = 0.10* In Delay = 0.6 Sec	I_0 = 0.3 A (neutral phase)	Trip after 0.6 sec	
51P	Pickup = 1.00* In TMS = 0.8 Sec IEC curve B	I = 5 A (Any one of phase)	Trip after 2.7 sec	
51N	Pickup = 0.1* In TMS = 0.8 Sec IEC curve C	I = 1 A (Any one of phase)	Trip after 0.69 sec	
27P	Pickup = 0.7* Vn Delay = 2 Sec Vs =110V (P-P)	V = 30V (Any one of phase)	Trip after 2 sec	
59P	Pickup = 1.2* Vn Delay = 2 Sec Vs =110V	V = 138V (Phase to phase)	Trip after 2 sec	
64	Pickup = 0.02* In Delay = 0.3 Sec	I_0 = 0.03 A (REF CT)	Trip after 0.3 sec	

Communication test

- Make the port connection as per the protocol selected. (Refer Chapter 4)
- Connect relay to the SCADA/DCS system with communication cable. (Cable selection is as per protocol selected)
- To connect Relay to PC with COMPfiguratorTM use front port USB.
- Confirm that Relay front port driver is installed in your PC.
- Check the configuration settings at relay end and at SCADA/DCS end.

Commissioning testing

Commissioning testing is performed to ensure that control logic designed for the particular system working satisfactory with protection of the system.

To perform commissioning test:

1. Open the MCB or remove fuses to de-energise the control supply.
2. Isolate the Relay contact assigned to the TRIP output.

3. Assure the connection of contact inputs and outputs cable by performing continuity test.
4. Energize the Relay and apply control supply voltage signals to the contact inputs and outputs.
5. Connect Relay to PC using proper communication interface and protocol.
6. Communicate the relay with COMPfiguratorTM software by using administrator login.
7. Enter the Relay settings as per the provided settings guide.
8. Define the control supply voltage level and system settings for the system through COMPfiguratorTM.
9. Verify the Relay voltage IP and current IP connections.
10. Connect the AC test source current or voltage to appropriate Relay terminals.
11. Inject the rated current 1 or 5 A depending upon current CT secondary ratio and rated voltage, and considering CT & VT ratios, measure the values of current and voltage through metering menu of display. Verify that the Relay is measuring the magnitude and phase angle correctly.
12. Verify contact inputs status through display.
13. Download the control logic into relay, designed for the system using COMPlogicTM.
14. Verify output contact operation as well as protections as per the logic.
15. Check all the metering parameters.
16. Clear all history events, data recorder, oscillography data.
17. Energize the feeder after all the functions testing are performed.

Troubleshooting

Table 10-2: Troubleshooting of relay

Problem	Condition	How to troubleshoot
Relay is de-energised.	Power input is not present.	Check the fuse continuity to test if the fuse is blown
	Thermal shutdown due to overvoltage in auxiliary control supply.	Check the supply voltage multi-meter. The relay will energise automatically again after defined period.
Relay unable to communicate with PC HMI.	Loss of cable connection.	Cable not properly connected / Due to breaking of the cable.
	Front port USB driver not installed	Install front port USB driver when USB is detected.
	Communication settings not matching between master and slave	Check communication settings at relay end and at PC end. Keep baud rate, stop bit, parity same in case of serial communication.
	Communication port is not selected property.	Check communication port from device manager, & select it properly in Device setup.
The Relay does not measure/display accurate	Loose Wiring	Check the wiring and connectivity of the cables as per the schematics.

values of voltages and currents	Incompatibility between the Relay and Display Firmware.	Consult the Relay manufacturer.
The Relay is not responding to a fault.	Improper settings	Protection might be not enabled. Ensure proper settings in the test source. Also, verify if current injection is as per the range.
	Connection not proper	Check the wiring and connections.
The Relay is not behaving as per new settings.	New settings are not saved.	Ensure if new settings are saved. If settings are done through the Display or through the COMPfigurator™.

Miscellaneous

How to assign trip to breaker from Relay?

Need to assign contact output for protection trip bit through COMPlogicTM. The trip signal to breaker can be provided in local as well as remote mode.

Local: Through Pushbuttons available on Relay front panel or through digital input signal given to relay configured as trip to breaker.

Remote: Through communication protocol.

How to assign close to breaker from Relay?

Need to assign contact output for protection close bit through COMPlogicTM. The close signal to breaker can be provided in local as well as remote mode.

Local: Through Pushbuttons available on Relay front panel or through digital input signal given to relay configured as close to breaker.

Remote: Through communication protocol.

How to reset the lockout condition Relay?

Need to assign contact input for reset of the latch functionality through COMPlogicTM. The reset signal to relay can be provided in local as well as remote mode.

Local: Through Pushbuttons available on Relay front panel or through digital input signal given to relay configured as reset to relay.

Remote: Through communication protocol.

Annexure A

MAPPING

Modbus memory mapping

Modbus memory map enlists all metering parameters, trip & event record parameters, DI/DO status and coil status. Function codes for different registers are also mentioned. The Modbus memory map shows the addresses for slow scan parameters for both modbus RTU and TCPIP. Different parameters can be configured as fast scan parameters at these addresses through COMPfiguratorTM.

General Settings

Table A-1: Product Settings Map

Attribute Name	Size (bytes)	Min. Value	Max. Value	Multiplier	Memory address
Date & Time					
Date	2	1	31	1	48345
Month	2	1	12	1	48346
Year	2	2010	2999	1	48347
Hour	2	0	23	1	48348
Minute	2	0	59	1	48349
Second	2	0	59	1	48350
Millisecond	2	0	999	1	48351
SNTP Settings					
Function	2	0	1	1	48210
Server IP Address 0 (Low)	2	0	255	1	48211
Server IP Address 1	2	0	255	1	48212
Server IP Address 2	2	0	255	1	48213
Server IP Address 3 (High)	2	0	255	1	48214
Valid IP Address 0 (Low)	2	0	255	1	48215
Valid IP Address 1	2	0	255	1	48216
Valid IP Address 2	2	0	255	1	48217
Valid IP Address 3 (High)	2	0	255	1	48218

UDP Port Number	2	1	65535	1	48219
Modbus RTU settings					
Node Address	2	1	247	1	48166
Parity	2	0	2	1	48167
Baud Rate	2	0	7	1	48168
Stop Bits	2	1	2	1	48169
Modbus TCPIP Settings					
IP Address 0 (Low)	2	0	255	1	48172
IP Address 1	2	0	255	1	48173
IP Address 2	2	0	255	1	48174
IP Address 3 (High)	2	0	255	1	48175
IP Subnet Mask 0 (Low)	2	0	255	1	48176
IP Subnet Mask 1	2	0	255	1	48177
IP Subnet Mask 2	2	0	255	1	48178
IP Subnet Mask 3 (High)	2	0	255	1	48179
Gateway IP Address 0 (Low)	2	0	255	1	48180
Gateway IP Address 1	2	0	255	1	48181
Gateway IP Address 2	2	0	255	1	48182
Gateway IP Address 3 (High)	2	0	255	1	48183
OSI Network Address 0 (Low)	2	0	255	1	48184
OSI Network Address 1	2	0	255	1	48185
OSI Network Address 2	2	0	255	1	48186
OSI Network Address 3 (High)	2	0	255	1	48187
Profibus Settings					
Function (Profibus En /D)	2	0	1	1	48393
Node Address	2	1	126	1	48394
IEC 61850 Settings					
IP Address 0 (Low)	2	0	255	1	48500
IP Address 1	2	0	255	1	48501

IP Address 2	2	0	255	1	48502
IP Address 3 (High)	2	0	255	1	48503
IP Subnet Mask 0 (Low)	2	0	255	1	48504
IP Subnet Mask 1	2	0	255	1	48505
IP Subnet Mask 2	2	0	255	1	48506
IP Subnet Mask 3 (High)	2	0	255	1	48507
Gateway IP Address 0 (Low)	2	0	255	1	48508
Gateway IP Address 1	2	0	255	1	48509
Gateway IP Address 2	2	0	255	1	48510
Gateway IP Address 3 (High)	2	0	255	1	48511
OSI Network Address 0 (Low)	2	0	255	1	48512
OSI Network Address 1	2	0	255	1	48513
OSI Network Address 2	2	0	255	1	48514
OSI Network Address 3 (High)	2	0	255	1	48515
Annunciator					
Parameter Selection 1	2	1	911	1	48397
Parameter Selection 2	2	1	911	1	48398
Parameter Selection 3	2	1	911	1	48399
Parameter Selection 4	2	1	911	1	48400
Parameter Selection 5	2	1	911	1	48401
Parameter Selection 6	2	1	911	1	48402
Parameter Selection 7	2	1	911	1	48403
Parameter Selection 8	2	1	911	1	48404
Parameter Selection 9	2	1	911	1	48405
Parameter Selection 10	2	1	911	1	48406
Parameter Selection 11	2	1	911	1	48407
Parameter Selection 12	2	1	911	1	48408
SLD Settings					
Label 1	40	0	65535	1	48410

Label 2	40	0	65535	1	48430
Parameter 1	2	0	57	1	48450
Parameter 2	2	0	57	1	48451
Parameter 3	2	0	57	1	48452
Parameter 4	2	0	57	1	48453
Parameter 5	2	0	57	1	48454
Parameter 6	2	0	57	1	48455
Demand					
Current Demand Method	2	0	2	1	48321
Power Demand Method	2	0	2	1	48322
Interval Time	2	0	2	1	48323
Slidding Window	2	0	2	1	48324
User Passward					
Password	8	0	65535	1	48550

Table A2: Disturbance Records Settings Map

Attribute Name	Size (bytes)	Min. Value	Max. Value	Multiplier	Memory address
Event Log					
Channel 1	2	0	57	1	48352
Channel 2	2	0	57	1	48353
Channel 3	2	0	57	1	48354
Channel 4	2	0	57	1	48355
Channel 5	2	0	57	1	48356
Channel 6	2	0	57	1	48357
Channel 7	2	0	57	1	48358
Channel 8	2	0	57	1	48359
Parameter Selection 1	2	1	911	1	48360
Parameter Selection 2	2	1	911	1	48361

Parameter Selection 3	2	1	911	1	48362
Parameter Selection 4	2	1	911	1	48363
Parameter Selection 5	2	1	911	1	48364
Parameter Selection 6	2	1	911	1	48365
Parameter Selection 7	2	1	911	1	48366
Parameter Selection 8	2	1	911	1	48367
Parameter Selection 9	2	1	911	1	48368
Parameter Selection 10	2	1	911	1	48369
Parameter Selection 11	2	1	911	1	48370
Parameter Selection 12	2	1	911	1	48371
Parameter Selection 13	2	1	911	1	48372
Parameter Selection 14	2	1	911	1	48373
Parameter Selection 15	2	1	911	1	48374
Parameter Selection 16	2	1	911	1	48375
Parameter Selection 17	2	1	911	1	48376
Parameter Selection 18	2	1	911	1	48377
Parameter Selection 19	2	1	911	1	48378
Parameter Selection 20	2	1	911	1	48379
Parameter Selection 21	2	1	911	1	48380
Parameter Selection 22	2	1	911	1	48381
Parameter Selection 23	2	1	911	1	48382
Parameter Selection 24	2	1	911	1	48383
Parameter Selection 25	2	1	911	1	48384
Parameter Selection 26	2	1	911	1	48385
Parameter Selection 27	2	1	911	1	48386
Parameter Selection 28	2	1	911	1	48387
Parameter Selection 29	2	1	911	1	48388
Parameter Selection 30	2	1	911	1	48389
Parameter Selection 31	2	1	911	1	48390

Parameter Selection 32	2	1	911	1	48391
Oscillography					
Oscillography Trigger Position	2	0	100	1	48256
Oscillography Total Cycle	2	0	3	1	48257
Channel 1	2	0	61	1	48260
Channel 2	2	0	61	1	48261
Channel 3	2	0	61	1	48262
Channel 4	2	0	61	1	48263
Channel 5	2	0	61	1	48264
Channel 6	2	0	61	1	48265
Parameter Selection 1	2	1	911	1	48268
Parameter Selection 2	2	1	911	1	48269
Parameter Selection 3	2	1	911	1	48270
Parameter Selection 4	2	1	911	1	48271
Parameter Selection 5	2	1	911	1	48272
Parameter Selection 6	2	1	911	1	48273
Parameter Selection 7	2	1	911	1	48274
Parameter Selection 8	2	1	911	1	48275
Parameter Selection 9	2	1	911	1	48276
Parameter Selection 10	2	1	911	1	48277
Parameter Selection 11	2	1	911	1	48278
Parameter Selection 12	2	1	911	1	48279
Parameter Selection 13	2	1	911	1	48280
Parameter Selection 14	2	1	911	1	48281
Parameter Selection 15	2	1	911	1	48282
Parameter Selection 16	2	1	911	1	48283
Parameter Selection 17	2	1	911	1	48284
Parameter Selection 18	2	1	911	1	48285
Parameter Selection 19	2	1	911	1	48286

Parameter Selection 20	2	1	911	1	48287
Parameter Selection 21	2	1	911	1	48288
Parameter Selection 22	2	1	911	1	48289
Parameter Selection 23	2	1	911	1	48290
Parameter Selection 24	2	1	911	1	48291
Parameter Selection 25	2	1	911	1	48292
Parameter Selection 26	2	1	911	1	48293
Parameter Selection 27	2	1	911	1	48294
Parameter Selection 28	2	1	911	1	48295
Parameter Selection 29	2	1	911	1	48296
Parameter Selection 30	2	1	911	1	48297
Parameter Selection 31	2	1	911	1	48298
Parameter Selection 32	2	1	911	1	48299
Data Recorder Settings					
Data Logger Rate (seconds)	4	15	3600000	1	48301
Channel 1	2	0	57	1	48303
Channel 2	2	0	57	1	48304
Channel 3	2	0	57	1	48305
Channel 4	2	0	57	1	48306
Channel 5	2	0	57	1	48307
Channel 6	2	0	57	1	48308
Channel 7	2	0	57	1	48309
Channel 8	2	0	57	1	48310
Channel 9	2	0	57	1	48311
Channel 10	2	0	57	1	48312
Channel 11	2	0	57	1	48313
Channel 12	2	0	57	1	48314
Channel 13	2	0	57	1	48315
Channel 14	2	0	57	1	48316

Channel 15	2	0	57	1	48317
Channel 16	2	0	57	1	48318

Table A-3: System Settings Map

Attribute Name	Size (bytes)	Min. Value	Max. Value	Multiplier	Memory address
Phase CT Primary	2	1	50000	1	48327
Phase CT Secondary	2	1	5	1	48328
SEF/Ground CT Primary	2	1	50000	1	48329
SEF/Ground CT Secondary	2	1	5	1	48330
REF CT Primary	2	1	50000	1	48331
REF CT Secondary	2	1	5	1	48332
Phase VT connection	2	0	1	1	48333
Phase VT Primary	4	100	40000000	1/100	48334
Phase VT secondary	2	500	30000	1/100	48336
Nominal Frequency	2	0	1	1	48337
Phase rotation	2	0	1	1	48338
Enable Demand Metering	2	0	1	1	48339
SEF Selection	2	0	1	1	48342

Protection Settings

Table A-4: Protection Settings Map

Attribute Name	Size (bytes)	Min. Value	Max. Value	Multiply	Address Group 1	Address Group 2	Address Group 3	Address Group 4
Instantaneous Phase Overcurrent								
Stage1 Function	2	0	1	1	40001	41911	43821	45731
Stage1 Measurement type	2	0	1	1	40002	41912	43822	45732
Stage1 Pickup (xIn)	2	100	20000	1/1000	40004	41914	43824	45734
Stage1_Delay	4	0	600000	1/1000	40005	41915	43825	45735

Stage2 Function	2	0	1	1	40010	41920	43830	45740
Stage2 Measurement type	2	0	1	1	40011	41921	43831	45741
Stage2 Pickup (xIn)	2	100	20000	1/1000	40013	41923	43833	45743
Stage2_Delay	4	0	600000	1/1000	40014	41924	43834	45744
Stage3 Function	2	0	1	1	40019	41929	43839	45749
Stage3 Measurement type	2	0	1	1	40020	41930	43840	45750
Stage3 Pickup (xIn)	2	100	20000	1/1000	40022	41932	43842	45752
Stage3_Delay	4	0	600000	1/1000	40023	41933	43843	45753
Stage4 Function	2	0	1	1	40028	41938	43848	45758
Stage4 Measurement type	2	0	1	1	40029	41939	43849	45759
Stage4 Pickup (xIn)	2	100	20000	1/1000	40031	41941	43851	45761
Stage4_Delay	4	0	600000	1/1000	40032	41942	43852	45762
Alarm Function	2	0	1	1	40037	41947	43857	45767
Alarm (% pickup)	2	25	80	1	40038	41948	43858	45768
Instantaneous Neutral Overcurrent								
Stage1 Function	2	0	1	1	40040	41950	43860	45770
Stage1 Measurement type	2	0	1	1	40041	41951	43861	45771
Stage1 Pickup (xIn)	2	100	20000	1/1000	40043	41953	43863	45773
Stage1_Delay	4	0	600000	1/1000	40044	41954	43864	45774
Stage2 Function	2	0	1	1	40049	41959	43869	45779
Stage2 Measurement type	2	0	1	1	40050	41960	43870	45780
Stage2 Pickup (xIn)	2	100	20000	1/1000	40052	41962	43872	45782
Stage2_Delay	4	0	600000	1/1000	40053	41963	43873	45783
Stage3 Function	2	0	1	1	40058	41968	43878	45788
Stage3 Measurement type	2	0	1	1	40059	41969	43879	45789
Stage3 Pickup (xIn)	2	100	20000	1/1000	40061	41971	43881	45791

Stage3_Delay	4	0	600000	1/1000	40062	41972	43882	45792
Stage4 Function	2	0	1	1	40067	41977	43887	45797
Stage4 Measurement type	2	0	1	1	40068	41978	43888	45798
Stage4 Pickup (xIn)	2	100	20000	1/1000	40070	41980	43890	45800
Stage4_Delay	4	0	600000	1/1000	40071	41981	43891	45801
Alarm Function	2	0	1	1	40076	41986	43896	45806
Alarm (% pickup)	2	25	80	1	40077	41987	43897	45807
Instantaneous Ground Overcurrent								
Stage1 Function	2	0	1	1	40079	41989	43899	45809
Stage1 Measurement type	2	0	1	1	40080	41990	43900	45810
Stage1 Pickup (xIn)	2	100	20000	1/1000	40082	41992	43902	45812
Stage1_Delay	4	0	600000	1/1000	40083	41993	43903	45813
Stage2 Function	2	0	1	1	40088	41998	43908	45818
Stage2 Measurement type	2	0	1	1	40089	41999	43909	45819
Stage2 Pickup (xIn)	2	100	20000	1/1000	40091	42001	43911	45821
Stage2_Delay	4	0	600000	1/1000	40092	42002	43912	45822
Stage3 Function	2	0	1	1	40097	42007	43917	45827
Stage3 Measurement type	2	0	1	1	40098	42008	43918	45828
Stage3 Pickup (xIn)	2	100	20000	1/1000	40100	42010	43920	45830
Stage3_Delay	4	0	600000	1/1000	40101	42011	43921	45831
Stage4 Function	2	0	1	1	40106	42016	43926	45836
Stage4 Measurement type	2	0	1	1	40107	42017	43927	45837
Stage4 Pickup (xIn)	2	100	20000	1/1000	40109	42019	43929	45839
Stage4_Delay	4	0	600000	1/1000	40110	42020	43930	45840
Alarm Function	2	0	1	1	40115	42025	43935	45845
Alarm (% pickup)	2	25	80	1	40116	42026	43936	45846
Instantaneous negative sequence overcurrent								

Stage1 Function	2	0	1	1	40118	42028	43938	45848
Stage1 Pickup (xIn)	2	100	3200	1/1000	40120	42030	43940	45850
Stage1_Delay	4	0	600000	1/1000	40122	42032	43942	45852
Stage2 Function	2	0	1	1	40126	42036	43946	45856
Stage2 Pickup (xIn)	2	100	3200	1/1000	40128	42038	43948	45858
Stage2 Delay	4	0	600000	1/1000	40130	42040	43950	45860
Stage3 Function	2	0	1	1	40134	42044	43954	45864
Stage3 Pickup (xIn)	2	100	3200	1/1000	40136	42046	43956	45866
Stage3 Delay	4	0	600000	1/1000	40138	42048	43958	45868
Stage4 Function	2	0	1	1	40142	42052	43962	45872
Stage4 Pickup (xIn)	2	100	3200	1/1000	40144	42054	43964	45874
Stage4 Delay	4	0	600000	1/1000	40146	42056	43966	45876
Alarm Function	2	0	1	1	40150	42060	43970	45880
Alarm (% pickup)	2	25	80	1	40151	42061	43971	45881
Thermal Overload								
Function	2	0	1	1	40292	42202	44112	46022
Pickup (xIn)	2	100	4000	1/1000	40293	42203	44113	46023
T1 Pickup Delay	4	60000	30000000	1/1000	40296	42206	44116	46026
Alarm Function	2	0	1	1	40298	42208	44118	46028
Alarm (% pickup)	2	25	80	1	40299	42209	44119	46029
K constant	2	10	400	1/100	40300	42210	44120	46030
Phase Undercurrent								
Function	2	0	1	1	40265	42175	44085	45995
Measurement Type	2	0	1	1	40266	42176	44086	45996
Pickup (xIn)	2	100	3200	1/1000	40268	42178	44088	45998
Delay	4	0	600000	1/1000	40269	42179	44089	45999
Alarm Function	2	0	1	1	40271	42181	44091	46001
Alarm (% pickup)	2	25	80	1	40272	42182	44092	46002
Restricted Earth Fault								

Function	2	0	1	1	40283	42193	44103	46013
Measurement Type	2	0	1	1	40284	42194	44104	46014
Pickup (xIn)	2	20	1000	1/1000	40286	42196	44106	46016
Delay	2	0	1000	1/1000	40287	42197	44107	46017
Alarm Function	2	0	1	1	40288	42198	44108	46018
Alarm (% pickup)	2	25	80	1	40289	42199	44109	46019
Sensitive Ground Instantaneous overcurrent								
Function	2	0	1	1	40153	42063	43973	45883
Measurement type	2	0	1	1	40154	42064	43974	45884
Pickup (xIn)	2	25	16000	1/10000	40156	42066	43976	45886
Delay	4	0	600000	1/1000	40157	42067	43977	45887
Alarm Function	2	0	1	1	40161	42071	43981	45891
Alarm (% pickup)	2	25	80	1	40162	42072	43982	45892
Phase Over Voltage								
Stage1 Function	2	0	1	1	40389	42299	44209	46119
Stage1 Mode	2	0	1	1	40391	42301	44211	46121
Stage1 Pickup (xVn)	2	20	1200	1/1000	40392	42302	44212	46122
Stage1 Delay	4	0	600000	1/1000	40393	42303	44213	46123
Stage1 Curve Type	2	0	1	1	40395	42305	44215	46125
Stage1 Block voltage (%Vn)	2	0	75	1	40396	42306	44216	46126
Stage2 Function	2	0	1	1	40401	42311	44221	46131
Stage2 Mode	2	0	1	1	40403	42313	44223	46133
Stage2 Pickup (xVn)	2	20	1200	1/1000	40404	42314	44224	46134
Stage2 Delay	4	0	600000	1/1000	40405	42315	44225	46135
Stage2 Curve Type	2	0	1	1	40407	42317	44227	46137
Stage2 Block voltage (%Vn)	2	0	75	1	40408	42318	44228	46138
Stage2 Reset	4	0	600000	1/1000	40409	42319	44229	46139

Stage3 Function	2	0	1	1	40413	42323	44233	46143
Stage3 Mode	2	0	1	1	40415	42325	44235	46145
Stage3 Pickup (xVn)	2	20	1200	1/1000	40416	42326	44236	46146
Stage3 Delay	4	0	600000	1/1000	40417	42327	44237	46147
Stage3 Curve Type	2	0	1	1	40419	42329	44239	46149
Stage3 Block voltage (%Vn)	2	0	75	1	40420	42330	44240	46150
Stage3 Reset	4	0	600000	1/1000	40421	42331	44241	46151
Alarm Function	2	0	1	1	40425	42335	44245	46155
Alarm (% pickup)	2	25	80	1	40426	42336	44246	46156
Phase Undervoltage								
Stage1 Function	2	0	1	1	40350	42260	44170	46080
Stage1 Mode	2	0	1	1	40352	42262	44172	46082
Stage1 Pickup (xVn)	2	20	1200	1/1000	40353	42263	44173	46083
Stage1Delay	4	0	600000	1/1000	40354	42264	44174	46084
Stage1 Curve Type	2	0	1	1	40356	42266	44176	46086
Stage1 Block voltage (%Vn)	2	0	75	1	40357	42267	44177	46087
Stage1 Reset	4	0	600	1/1000	40358	42268	44178	46088
Stage2 Function	2	0	1	1	40362	42272	44182	46092
Stage2 Mode	2	0	1	1	40364	42274	44184	46094
Stage2 Pickup (xVn)	2	20	1200	1/1000	40365	42275	44185	46095
Stage2 Delay	4	0	600000	1/1000	40366	42276	44186	46096
Stage2 Curve Type	2	0	1	1	40368	42278	44188	46098
Stage2 Block voltage (%Vn)	2	0	75	1	40369	42279	44189	46099
Stage2 Reset	4	0	600	1/1000	40370	42280	44190	46100
Stage3 Function	2	0	1	1	40374	42284	44194	46104
Stage3 Mode	2	0	1	1	40376	42286	44196	46106

Stage3 Pickup (xVn)	2	20	1200	1/1000	40377	42287	44197	46107
Stage3 Delay	4	0	600000	1/1000	40378	42288	44198	46108
Stage3 Curve Type	2	0	1	1	40380	42290	44200	46110
Stage3 Block voltage (%Vn)	2	0	75	1	40381	42291	44201	46111
Stage3 Reset	4	0	600	1/1000	40382	42292	44202	46112
Alarm Function	2	0	1	1	40386	42296	44206	46116
Alarm (% pickup)	2	25	80	1	40387	42297	44207	46117
Residual Overvoltage								
Stage1 Function	2	0	1	1	40428	42338	44248	46158
Stage1 Mode	2	0	1	1	40430	42340	44250	46160
Stage1 Pickup (xVn)	2	20	1200	1/1000	40431	42341	44251	46161
Stage1 Delay	4	0	600000	1/1000	40432	42342	44252	46162
Stage1 Curve Type	2	0	1	1	40434	42344	44254	46164
Stage1 Block voltage (%Vn)	2	0	75	1	40435	42345	44255	46165
Stage1 Reset	4	0	600000	1/1000	40436	42346	44256	46166
Stage2 Function	2	0	1	1	40440	42350	44260	46170
Stage2 Mode	2	0	1	1	40442	42352	44262	46172
Stage2 Pickup (xVn)	2	20	1200	1/1000	40443	42353	44263	46173
Stage2 Delay	4	0	600000	1/1000	40444	42354	44264	46174
Stage2 Curve Type	2	0	1	1	40446	42356	44266	46176
Stage2 Block voltage (%Vn)	2	0	75	1	40447	42357	44267	46177
Stage2 Reset	4	0	600000	1/1000	40448	42358	44268	46178
Stage3 Function	2	0	1	1	40452	42362	44272	46182
Stage3 Mode	2	0	1	1	40454	42364	44274	46184
Stage3 Pickup (xVn)	2	20	1200	1/1000	40455	42365	44275	46185
Stage3 Delay	4	0	600000	1/1000	40456	42366	44276	46186

Stage3 Curve Type	2	0	1	1	40458	42368	44278	46188
Stage3 Block voltage (%Vn)	2	0	75	1	40459	42369	44279	46189
Stage3 Reset	4	0	600000	1/1000	40460	42370	44280	46190
Alarm Function	2	0	1	1	40464	42374	44284	46194
Alarm (% pickup)	2	25	80	1	40465	42375	44285	46195
Positive Sequence Overvoltage								
Stage1 Function	2	0	1	1	40467	42377	44287	46230
Stage1 Mode	2	0	1	1	40469	42379	44289	46232
Stage1 Pickup (xVn)	2	20	1200	1/1000	40470	42380	44290	46233
Stage1 Delay	4	0	600000	1/1000	40471	42381	44291	46234
Stage1 Reset	4	0	600000	1/1000	40473	42383	44293	46236
Stage2 Function	2	0	1	1	40477	42387	44297	46240
Stage2 Mode	2	0	1	1	40479	42389	44299	46242
Stage2 Pickup (xVn)	2	20	1200	1/1000	40480	42390	44300	46243
Stage2 Delay	4	0	600000	1/1000	40481	42391	44301	46244
Stage2 Reset	4	0	600000	1/1000	40483	42393	44303	46246
Stage3 Function	2	0	1	1	40487	42397	44307	46250
Stage3 Mode	2	0	1	1	40489	42399	44309	46252
Stage3 Pickup (xVn)	2	20	1200	1/1000	40490	42400	44310	46253
Stage3 Delay	4	0	600000	1/1000	40491	42401	44311	46254
Stage3 Reset	4	0	600000	1/1000	40493	42403	44313	46256
Alarm Function	2	0	1	1	40497	42407	44317	46260
Alarm (% pickup)	2	25	80	1	40498	42408	44318	46261
Sync Undervoltage								
Protection Function	2	0	1	1	40566	42476	44386	46296
Stage1 Pickup	2	20	1200	1	40569	42479	44389	46299
Stage1 Delay	4	0	600000	1/1000	40570	42480	44390	46300

Alarm Function	2	0	1	1	40572	42482	44392	46302
Alarm (% pickup)	2	25	80	1	40573	42483	44393	46303
Stage1 Block voltage (%Vn)	2	0	75	1	40574	42484	44394	46304
Sync Overvoltage								
Protection Function	2	0	1	1	40575	42485	44395	46305
Stage1 Pickup (xVn)	2	20	1200	1	40578	42488	44398	46308
Stage1 Delay	4	0	600000	1/1000	40579	42489	44399	46309
Alarm Function	2	0	1	1	40581	42491	44401	46311
Alarm (% pickup)	2	25	80	1	40582	42492	44402	46312
Stage1 Block voltage (%Vn)	2	0	75	1	40583	42493	44403	46313
Underfrequency								
Stage1 Function	2	0	1	1	40584	42494	44404	46314
Stage1 Pickup	2	2000	7000	1/100	40586	42496	44406	46316
Stage1Delay	4	0	100000	1/1000	40588	42498	44408	46318
Stage2 Function	2	0	1	1	40590	42500	44410	46320
Stage2 Pickup	2	2000	7000	1/100	40592	42502	44412	46322
Stage2Delay	4	0	100000	1/1000	40594	42504	44414	46324
Stage3 Function	2	0	1	1	40596	42506	44416	46326
Stage3 Pickup	2	2000	7000	1/100	40598	42508	44418	46328
Stage3Delay	4	0	100000	1/1000	40600	42510	44420	46330
Stage4 Function	2	0	1	1	40602	42512	44422	46332
Stage4 Pickup	2	2000	7000	1/100	40604	42514	44424	46334
Stage4Delay	4	0	100000	1/1000	40606	42516	44426	46336
Stage5 Function	2	0	1	1	40608	42518	44428	46338
Stage5 Pickup	2	2000	7000	1/100	40610	42520	44430	46340
Stage5Delay	4	0	100000	1/1000	40612	42522	44432	46342
Stage6 Function	2	0	1	1	40614	42524	44434	46344
Stage6 Pickup	2	2000	7000	1/100	40616	42526	44436	46346

Stage6Delay	4	0	100000	1/1000	40618	42528	44438	46348
Minimum voltage (Vn)	2	600	1250	1/1000	40620	42530	44440	46350
Alarm Function	2	0	1	1	40622	42532	44442	46352
Alarm (% pickup)	2	1250	7000	1/100	40623	42533	44443	46353
Overfrequency								
Stage1 Function	2	0	1	1	40625	42535	44445	46355
Stage1 Pickup	2	2000	7000	1/100	40627	42537	44447	46357
Stage1Delay	4	0	100000	1/1000	40629	42539	44449	46359
Stage2 Function	2	0	1	1	40631	42541	44451	46361
Stage2 Pickup	2	2000	7000	1/100	40633	42543	44453	46363
Stage2Delay	4	0	100000	1/1000	40635	42545	44455	46365
Stage3 Function	2	0	1	1	40637	42547	44457	46367
Stage3 Pickup	2	2000	7000	1/100	40639	42549	44459	46369
Stage3Delay	4	0	100000	1/1000	40641	42551	44461	46371
Stage4 Function	2	0	1	1	40643	42553	44463	46373
Stage4 Pickup	2	2000	7000	1/100	40645	42555	44465	46375
Stage4Delay	4	0	100000	1/1000	40647	42557	44467	46377
Stage5 Function	2	0	1	1	40649	42559	44469	46379
Stage5 Pickup	2	2000	7000	1/100	40651	42561	44471	46381
Stage5Delay	4	0	100000	1/1000	40653	42563	44473	46383
Stage6 Function	2	0	1	1	40655	42565	44475	46385
Stage6 Pickup	2	2000	7000	1/100	40657	42567	44477	46387
Stage6Delay	4	0	100000	1/1000	40659	42569	44479	46389
Minimum voltage (Vn)	2	600	1250	1/1000	40661	42571	44481	46391
Alarm Function	2	0	1	1	40663	42573	44483	46393
Alarm (% pickup)	2	1250	7000	1/100	40664	42574	44484	46394
Frequency Gradient								
Stage1 Function	2	0	1	1	40666	42576	44486	46396

Stage1 Trend	2	0	2	1	40668	42578	44488	46398
Stage1 Pickup	2	10	20000	1/1000	40669	42579	44489	46399
Stage1 OV Supervision	2	100	1200	1/1000	40670	42580	44490	46400
Stage1 Minimum	2	2000	7000	1/100	40672	42582	44492	46402
Stage1 Maximum	2	2000	7000	1/100	40673	42583	44493	46403
Stage1 Pickup Delay	4	0	100000	1/1000	40674	42584	44494	46404
Stage2 Function	2	0	1	1	40678	42588	44498	46408
Stage2 Trend	2	0	2	1	40680	42590	44500	46410
Stage2 Pickup	2	10	20000	1/1000	40681	42591	44501	46411
Stage2 OV Supervision	2	100	1200	1/1000	40682	42592	44502	46412
Stage2 Minimum	2	2000	7000	1/100	40684	42594	44504	46414
Stage2 Maximum	2	2000	7000	1/100	40685	42595	44505	46415
Stage2 Pickup Delay	4	0	100000	1/1000	40686	42596	44506	46416
Stage3 Function	2	0	1	1	40690	42600	44510	46420
Stage3 Source	2	0	0	1	40691	42601	44511	46421
Stage3 Trend	2	0	2	1	40692	42602	44512	46422
Stage3 Pickup	2	10	20000	1/1000	40693	42603	44513	46423
Stage3 OV Supervision	2	100	1200	1/1000	40694	42604	44514	46424
Stage3 Minimum	2	2000	7000	1/100	40696	42606	44516	46426
Stage3 Maximum	2	2000	7000	1/100	40697	42607	44517	46427
Stage3 Pickup Delay	4	0	100000	1/1000	40698	42608	44518	46428
Stage4 Function	2	0	1	1	40702	42612	44522	46432
Stage4 Trend	2	0	2	1	40704	42614	44524	46434
Stage4 Pickup	2	10	20000	1/1000	40705	42615	44525	46435
Stage4 OV Supervision	2	100	1200	1/1000	40706	42616	44526	46436
Stage4 Minimum	2	2000	7000	1/100	40708	42618	44528	46438

Stage4 Maximum	2	2000	7000	1/100	40709	42619	44529	46439
Stage4 Pickup Delay	4	0	100000	1/1000	40710	42620	44530	46440
Alarm Function	2	0	1	1	40714	42624	44534	46444
Alarm (% pickup)	2	25	80	1	40715	42625	44535	46445
Under/Over Power								
Stage1 Function	2	0	1	1	40930	42840	44750	46660
Pickup parmater (W/VAR)	2	0	1	1	40931	42841	44751	46661
Over/Under power selection	2	0	1	1	40932	42842	44752	46662
Pickup	4	20	130000	1/100	40934	42844	44754	46664
Stage2 Function	2	0	1	1	40936	42846	44756	46666
Pickup parmater (W/VAR)	2	0	1	1	40937	42847	44757	46667
Over/Under power selection	2	0	1	1	40938	42848	44758	46668
Pickup	4	20	130000	1/100	40940	42850	44760	46670
Stage3 Function	2	0	1	1	40942	42852	44762	46672
Pickup parmater (W/VAR)	2	0	1	1	40943	42853	44763	46673
Over/Under power selection	2	0	1	1	40944	42854	44764	46674
Pickup	4	20	130000	1/100	40946	42856	44766	46676
Stage4 Function	2	0	1	1	40948	42858	44768	46678
Pickup parmater (W/VAR)	2	0	1	1	40949	42859	44769	46679
Over/Under power selection	2	0	1	1	40950	42860	44770	46680
Pickup	4	20	130000	1/100	40952	42862	44772	46682
Block Voltage	2	0	75	1	40954	42864	44774	46684
Block Current	2	100	550	1/1000	40955	42865	44775	46685
Reverse Power								
Function	2	0	1	1	40957	42867	44777	46687

Pickup Parameter (W/VAR)	2	0	1	1	40958	42868	44778	46688
Pickup	4	20	130000	1/100	40959	42869	44779	46689
Block Voltage	2	0	75	1	40961	42871	44781	46691
Block Current	2	100	550	1/1000	40962	42872	44782	46692
Lead Power Factor								
Function	2	0	1	1	40971	42881	44791	46701
Pickup Setting	2	5	95	1/100	40972	42882	44792	46702
Trip Delay	4	1000	240000	1/1000	40973	42883	44793	46703
Alarm Function	2	0	1	1	40975	42885	44795	46705
Alarm (%Pickup)	2	5	95	1/100	40976	42886	44796	46706
Alarm Delay	4	1000	240000	1/1000	40977	42887	44797	46707
Lag Power Factor								
Function	2	0	1	1	40993	42903	44813	46723
Pickup Setting	2	5	95	1/100	40994	42904	44814	46724
Trip Delay	4	1000	240000	1/1000	40995	42905	44815	46725
Alarm Function	2	0	1	1	40997	42907	44817	46727
Alarm (%Pickup)	2	5	95	1/100	40998	42908	44818	46728
Alarm Delay	4	1000	240000	1/1000	40999	42909	44819	46729
Directional Phase IOC								
Stage 1 Function	2	0	1	1	40724	42634	44544	46454
Stage 1 Measurement Type	2	0	1	1	40725	42635	44545	46455
Stage 1 Characteristic angle	2	-180	180	1	40726	42636	44546	46456
Stage 1 Direction	2	0	1	1	40728	42638	44548	46458
Stage 1 Polarisation	2	0	0	1	40729	42639	44549	46459
Stage 1 Voltage polarisation	2	0	1200	1/1000	40730	42640	44550	46460
Stage1 Forward Pickup (xIn)	2	100	20000	1/1000	40732	42642	44552	46462

Stage 1 Reverse Pickup	2	100	20000	1/1000	40733	42643	44553	46463
Stage1 Forward Delay	4	0	600000	1/1000	40734	42644	44554	46464
Stage 1 Reverse Delay	4	0	600000	1/1000	40736	42646	44556	46466
Stage 2 Function	2	0	1	1	40740	42650	44560	46470
Stage 2 Measurement Type	2	0	1	1	40741	42651	44561	46471
Stage 2 Characteristic angle	2	-180	180	1	40742	42652	44562	46472
Stage 2 Direction	2	0	1	1	40744	42654	44564	46474
Stage 2 Polarisation	2	0	0	1	40745	42655	44565	46475
Stage 2 Voltage polarisation	2	0	1200	1/1000	40746	42656	44566	46476
Stage 2 Forward Pickup (xIn)	2	100	20000	1/1000	40748	42658	44568	46478
Stage 2 Reverse Pickup	2	100	20000	1/1000	40749	42659	44569	46479
Stage 2 Forward Delay	4	0	600000	1/1000	40750	42660	44570	46480
Stage 2 Reverse Delay	4	0	600000	1/1000	40752	42662	44572	46482
Alarm Function	2	0	1	1	40756	42666	44576	46486
Alarm (%Pickup)	2	25	80	1	40757	42667	44577	46487
Directional Phase TOC								
Stage 1 Function	2	0	1	1	40759	42669	44579	46489
Stage 1 Measurement Type	2	0	1	1	40760	42670	44580	46490
Stage 1 Characteristic angle	2	-180	180	1	40761	42671	44581	46491
Stage 1 Direction	2	0	1	1	40763	42673	44583	46493
Stage 1 Polarisation	2	0	0	1	40765	42675	44585	46495
Stage 1 Voltage polarisation	2	0	1200	1/1000	40766	42676	44586	46496
Stage 1 Forward	2	0	5	1	40767	42677	44587	46497

Curve type								
Stage1 Forward Pickup (xIn)	2	100	3200	1/1000	40768	42678	44588	46498
Stage1 Forward Delay	4	0	600000	1/1000	40769	42679	44589	46499
Stage 1 Reverse Curve type	2	0	5	1	40771	42681	44591	46501
Stage1 Reverse Pickup (xIn)	2	100	3200	1/1000	40772	42682	44592	46502
Stage1 Reverse Delay	4	0	600000	1/1000	40773	42683	44593	46503
Stage 2 Function	2	0	1	1	40777	42687	44597	46507
Stage 2 Measurement Type	2	0	1	1	40778	42688	44598	46508
Stage 2 Characteristic angle	2	-180	180	1	40779	42689	44599	46509
Stage 2 Direction	2	0	1	1	40781	42691	44601	46511
Stage 2 Polarisation	2	0	0	1	40783	42693	44603	46513
Stage 2 Voltage polarisation	2	0	1200	1/1000	40784	42694	44604	46514
Stage 2 Forward Curve type	2	0	5	1	40785	42695	44605	46515
Stage 2 Forward Pickup (xIn)	2	100	3200	1/1000	40786	42696	44606	46516
Stage 2 Forward Delay	4	0	600000	1/1000	40787	42697	44607	46517
Stage 2 Reverse Curve type	2	0	5	1	40789	42699	44609	46519
Stage 2 Reverse Pickup (xIn)	2	100	3200	1/1000	40790	42700	44610	46520
Stage 2 Reverse Delay	4	0	600000	1/1000	40791	42701	44611	46521
Alarm Function	2	0	1	1	40795	42705	44615	46525
Alarm (%Pickup)	2	25	80	1	40796	42706	44616	46526
Directional Neutral IOC								
Stage 1 Function	2	0	1	1	40798	42708	44618	46528
Stage 1 Characteristic angle	2	-90	90	1	40799	42709	44619	46529

Stage 1 Voltage polarisation thershold	2	0	1200	1/1000	40801	42711	44621	46531
Stage 1 Positive sequence current restrain	2	100	3200	1/1000	40802	42712	44622	46532
Stage1 ForwardPickup (xIn)	2	100	20000	1/1000	40803	42713	44623	46533
Stage 1 ReversePickup(xIn)	2	100	20000	1/1000	40804	42714	44624	46534
Stage 1 Forward Delay	4	0	600000	1/1000	40806	42716	44626	46536
Stage 1 Reverse Delay	4	0	600000	1/1000	40808	42718	44628	46538
Stage 2 Function	2	0	1	1	40812	42722	44632	46542
Stage 2 Characteristic angle	2	-90	90	1	40813	42723	44633	46543
Stage 2 Voltage polarisation thershold	2	0	1200	1/1000	40815	42725	44635	46545
Stage 1 Positive sequence current restrain	2	100	3200	1/1000	40816	42726	44636	46546
Stage1 ForwardPickup (xIn)	2	100	20000	1/1000	40817	42727	44637	46547
Stage 2 ReversePickup(xIn)	2	100	20000	1/1000	40818	42728	44638	46548
Stage 2 Forward Delay	4	0	600000	1/1000	40820	42730	44640	46550
Stage 2 Reverse Delay	4	0	600000	1/1000	40822	42732	44642	46552
Alarm Function	2	0	1	1	40826	42736	44646	46556
Alarm (%Pickup)	2	25	80	1	40827	42737	44647	46557
Directional Neutral TOC								
Stage 1 Function	2	0	1	1	40829	42739	44649	46559
Stage 1 Characteristic angle	2	-90	90	1	40830	42740	44650	46560
Stage 1 Source	2	0	1	1	40831	42741	44651	46561
Stage 1 Voltage	2	0	1200	1/1000	40832	42742	44652	46562

polarisation thershold								
Stage 1 Positive sequence current restrain	2	100	3200	1/1000	40833	42743	44653	46563
Stage1 ForwardPickup (xIn)	2	100	20000	1/1000	40835	42745	44655	46565
Stage 1 Forward curve type	2	0	5	1	40836	42746	44656	46566
Stage 1 Forward Delay	4	0	600000	1/1000	40837	42747	44657	46567
Stage 1 ReversePickup(xIn)	2	100	20000	1/1000	40839	42749	44659	46569
Stage 1 Reverse curve type	2	0	5	1	40840	42750	44660	46570
Stage 1 Reverse Delay	4	0	600000	1/1000	40841	42751	44661	46571
Stage 2 Function	2	0	1	1	40845	42755	44665	46575
Stage 2 Characteristic angle	2	-90	90	1	40846	42756	44666	46576
Stage 2 Voltage polarisation thershold	2	0	1200	1/1000	40848	42758	44668	46578
Stage 1 Positive sequence current restrain	2	100	3200	1/1000	40849	42759	44669	46579
Stage2 ForwardPickup (xIn)	2	100	20000	1/1000	40851	42761	44671	46581
Stage 2 Forward curve type	2	0	5	1	40852	42762	44672	46582
Stage 2 Forward Delay	4	0	600000	1/1000	40853	42763	44673	46583
Stage 2 ReversePickup(xIn)	2	100	20000	1/1000	40855	42765	44675	46585
Stage 2 Reverse curve type	2	0	5	1	40856	42766	44676	46586
Stage 2 Reverse Delay	4	0	600000	1/1000	40857	42767	44677	46587
Alarm Function	2	0	1	1	40861	42771	44681	46591
Alarm (%Pickup)	2	25	80	1	40862	42772	44682	46592

Directional Ground IOC								
Stage 1 Function	2	0	1	1	40864	42774	44684	46594
Stage 1 Meassurement Type	2	0	1	1	40865	42775	44685	46595
Stage 1 Characteristic angle	2	-90	90	1	40866	42776	44686	46596
Stage 1 Voltage polarisation thershold	2	0	1200	1/1000	40868	42778	44688	46598
Stage 1 Positive sequence current restrain	2	100	3200	1/1000	40869	42779	44689	46599
Stage1 ForwardPickup (xIn)	2	100	20000	1/1000	40870	42780	44690	46600
Stage 1 ReversePickup(xIn)	2	100	20000	1/1000	40871	42781	44691	46601
Stage 1 Forward Delay	4	0	600000	1/1000	40872	42782	44692	46602
Stage 1 Reverse Delay	4	0	600000	1/1000	40874	42784	44694	46604
Stage 2 Function	2	0	1	1	40878	42788	44698	46608
Stage 2 Meassurement Type	2	0	1	1	40879	42789	44699	46609
Stage 2 Characteristic angle	2	-90	90	1	40880	42790	44700	46610
Stage 2 Voltage polarisation thershold	2	0	1200	1/1000	40882	42792	44702	46612
Stage 1 Positive sequence current restrain	2	100	3200	1/1000	40883	42793	44703	46613
Stage 2 ForwardPickup (xIn)	2	100	20000	1/1000	40884	42794	44704	46614
Stage 2 ReversePickup(xIn)	2	100	20000	1/1000	40885	42795	44705	46615
Stage 2 Forward Delay	4	0	600000	1/1000	40886	42796	44706	46616
Stage 2 Reverse Delay	4	0	600000	1/1000	40888	42798	44708	46618

Alarm Function	2	0	1	1	40892	42802	44712	46622
Alarm (%Pickup)	2	25	80	1	40893	42803	44713	46623
Directional Ground TOC								
Stage 1 Function	2	0	1	1	40895	42805	44715	46625
Stage 1 Measurement Type	2	0	1	1	40896	42806	44716	46626
Stage 1 Characteristic angle	2	-90	90	1	40897	42807	44717	46627
Stage 1 Voltage polarisation thershold	2	0	1200	1/1000	40899	42809	44719	46629
Stage 1 Positive sequence current restrain	2	100	3200	1/1000	40900	42810	44720	46630
Stage1 ForwardPickup (xIn)	2	100	20000	1/1000	40901	42811	44721	46631
Stage 1 Forward curve type	2	0	5	1	40902	42812	44722	46632
Stage 1 Forward Delay	4	0	600000	1/1000	40903	42813	44723	46633
Stage 1 ReversePickup(xIn)	2	100	20000	1/1000	40905	42815	44725	46635
Stage 1 Rverse curve type	2	0	5	1	40906	42816	44726	46636
Stage 1 Reverse Delay	4	0	600000	1/1000	40907	42817	44727	46637
Stage 2 Function	2	0	1	1	40911	42821	44731	46641
Stage 2 Meassurement Type	2	0	1	1	40912	42822	44732	46642
Stage 2 Characteristic angle	2	-90	90	1	40913	42823	44733	46643
Stage 2 Voltage polarisation thershold	2	0	1200	1/1000	40915	42825	44735	46645
Stage 1 Positive sequence current restrain	2	100	3200	1/1000	40916	42826	44736	46646
Stage2 ForwardPickup (xIn)	2	100	20000	1/1000	40917	42827	44737	46647

Stage 2 Forward curve type	2	0	5	1	40918	42828	44738	46648
Stage 2 Forward Delay	4	0	600000	1/1000	40919	42829	44739	46649
Stage 2 ReversePickup(xIn)	2	100	20000	1/1000	40921	42831	44741	46651
Stage 2 Rverse curve type	2	0	5	1	40922	42832	44742	46652
Stage 2 Reverse Delay	4	0	600000	1/1000	40923	42833	44743	46653
Alarm Function	2	0	1	1	40927	42837	44747	46657
Alarm (%Pickup)	2	25	80	1	40928	42838	44748	46658

Metering Map

Table A-5: Metering Map

Attribute Name	Size (bytes)	Min. Value	Max. Value	Multiplier	Memory address
Rph RMS Current	4	0	1000000000	1/1000	30001
Yph RMS Current	4	0	1000000000	1/1000	30003
Bph RMS Current	4	0	1000000000	1/1000	30005
Nph/SEF RMS Current	4	0	1000000000	1/1000	30007
Gph RMS Current	4	0	1000000000	1/1000	30009
REF RMS Current	4	0	1000000000	1/1000	30011
Rph RMS Voltage	4	0	720000000	1/100	30013
Yph RMS Voltage	4	0	720000000	1/100	30015
Bph RMS Voltage	4	0	720000000	1/100	30017
RYph RMS Voltage	4	0	1248000000	1/100	30019
YBph RMS Voltage	4	0	1248000000	1/100	30021
BRph RMS Voltage	4	0	1248000000	1/100	30023
Sync RMS Voltage	4	0	1248000000	1/100	30025
Residual RMS Voltage	4	0	720000000	1/100	30027
Rph current angle	2	0	360	1	30029

Yph current angle	2	0	360	1	30030
Bph current angle	2	0	360	1	30031
Nph current angle	2	0	360	1	30032
Gph current angle	2	0	360	1	30033
REFph current angle	2	0	360	1	30034
Rph voltage angle	2	0	360	1	30035
Yph voltage angle	2	0	360	1	30036
Bph voltage angle	2	0	360	1	30037
RYph voltage angle	2	0	360	1	30038
YBph voltage angle	2	0	360	1	30039
BRph voltage angle	2	0	360	1	30040
Residual voltage angle	2	0	360	1	30041
Sync voltage angle	2	0	360	1	30042
Fundamental Rph RMS Current	4	0	1000000000	1/1000	30043
Fundamental Yph RMS Current	4	0	1000000000	1/1000	30045
Fundamental Bph RMS Current	4	0	1000000000	1/1000	30047
Fundamental Nph/SEF RMS Current	4	0	1000000000	1/1000	30049
Fundamental Gph RMS Current	4	0	1000000000	1/1000	30051
Fundamental REF RMS Current	4	0	1000000000	1/1000	30053
Fundamental Rph RMS Voltage	4	0	720000000	1/100	30055
Fundamental Yph RMS Voltage	4	0	720000000	1/100	30057
Fundamental Bph RMS Voltage	4	0	720000000	1/100	30059
Fundamental RYph RMS Voltage	4	0	1248000000	1/100	30061
Fundamental YBph RMS Voltage	4	0	1248000000	1/100	30063
Fundamental BRph RMS Voltage	4	0	1248000000	1/100	30065
Rph Demand Current	4	0	1000000000	1/1000	30067

Yph Demand Current	4	0	1000000000	1/1000	30069
Bph Demand Current	4	0	1000000000	1/1000	30071
Nph/SEF Demand Current	4	0	1000000000	1/1000	30073
Gph Demand Current	4	0	1000000000	1/1000	30075
REF Demand Current	4	0	1000000000	1/1000	30077
Rph MAX Current	4	0	1000000000	1/1000	30079
Yph MAX Current	4	0	1000000000	1/1000	30081
Bph MAX Current	4	0	1000000000	1/1000	30083
Nph/SEF MAX Current	4	0	1000000000	1/1000	30085
Gph MAX Current	4	0	1000000000	1/1000	30087
REF MAX Current	4	0	1000000000	1/1000	30089
Rph MAX RMS Voltage	4	0	720000000	1/100	30091
Yph MAX RMS Voltage	4	0	720000000	1/100	30093
Bph MAX RMS Voltage	4	0	720000000	1/100	30095
RYph MAX RMS Voltage	4	0	1248000000	1/100	30097
YBph MAX RMS Voltage	4	0	1248000000	1/100	30099
BRph MAX RMS Voltage	4	0	1248000000	1/100	30101
Rph MIN Current	4	0	1000000000	1/1000	30103
Yph MIN Current	4	0	1000000000	1/1000	30105
Bph MIN Current	4	0	1000000000	1/1000	30107
Nph/SEF MIN Current	4	0	1000000000	1/1000	30109
Gph MIN Current	4	0	1000000000	1/1000	30111
REF MIN Current	4	0	1000000000	1/1000	30113
Rph MIN RMS Voltage	4	0	720000000	1/100	30115
Yph MIN RMS Voltage	4	0	720000000	1/100	30117
Bph MIN RMS Voltage	4	0	720000000	1/100	30119
RYph MIN RMS Voltage	4	0	1248000000	1/100	30121
YBph MIN RMS Voltage	4	0	1248000000	1/100	30123
BRph MIN RMS Voltage	4	0	1248000000	1/100	30125

Average Current	4	0	1000000000	1/1000	30127
RYBph Average RMS Voltage	4	0	720000000	1/100	30129
Voltage Unbalance	4	0	720000000	1/100	30131
Phase sequence	2	0	2	1	30133
Positive Sequence RMS Magnitude	4	0	1000000000	1/1000	30134
Negative Sequence RMS Magnitude	4	0	1000000000	1/1000	30136
Zero Sequence RMS Magnitude	4	0	1000000000	1/1000	30138
Positive Sequence RMS voltage Magnitude	4	0	720000000	1/100	30140
Negative Sequence RMS voltage Magnitude	4	0	720000000	1/100	30142
Zero Sequence RMS voltage Magnitude	4	0	720000000	1/100	30144
Positive Sequence Angle	2	0	360	1	30146
Negative Sequence Angle	2	0	360	1	30147
Zero Sequence Angle	2	0	360	1	30148
Positive Sequence Angle	2	0	360	1	30149
Negative Sequence Angle	2	0	360	1	30150
Zero Sequence Angle	2	0	360	1	30151
Rph Active Power	4	-2147483647	2147483647	1/100	30152
Yph Active Power	4	-2147483647	2147483647	1/100	30154
Bph Active Power	4	-2147483647	2147483647	1/100	30156
Rph Reactive Power	4	-2147483647	2147483647	1/100	30158
Yph Reactive Power	4	-2147483647	2147483647	1/100	30160
Bph Reactive Power	4	-2147483647	2147483647	1/100	30162
Rph Apparent Power	4	-2147483647	2147483647	1/100	30164
Yph Apparent Power	4	-2147483647	2147483647	1/100	30166
Bph Apparent Power	4	-2147483647	2147483647	1/100	30168
Total Active Power	4	-2147483647	2147483647	1/100	30170

Total Reactive Power	4	-2147483647	2147483647	1/100	30172
Total Apparent Power	4	-2147483647	2147483647	1/100	30174
Total Max Active Power	4	-2147483647	2147483647	1/100	30176
Total Max Reactive Power	4	-2147483647	2147483647	1/100	30178
Total Max Apparent Power	4	-2147483647	2147483647	1/100	30180
Total Min Active Power	4	-2147483647	2147483647	1/100	30182
Total Min Reactive Power	4	-2147483647	2147483647	1/100	30184
Total Min Apparent Power	4	-2147483647	2147483647	1/100	30186
MD Rph Active Power	4	-2147483647	2147483647	1/100	30188
MD Yph Active Power	4	-2147483647	2147483647	1/100	30190
MD Bph Active Power	4	-2147483647	2147483647	1/100	30192
MD Rph Reactive Power	4	-2147483647	2147483647	1/100	30194
MD Yph Reactive Power	4	-2147483647	2147483647	1/100	30196
MD Bph Reactive Power	4	-2147483647	2147483647	1/100	30198
MD Rph Apparent Power	4	-2147483647	2147483647	1/100	30200
MD Yph Apparent Power	4	-2147483647	2147483647	1/100	30202
MD Bph Apparent Power	4	-2147483647	2147483647	1/100	30204
Rph Active Power scale factor	2	0	9	1	30206
Yph Active Power scale factor	2	0	9	1	30207
Bph Active Power scale factor	2	0	9	1	30208
Rph Reactive Power scale factor	2	0	9	1	30209
Yph Reactive Power scale factor	2	0	9	1	30210
Bph Reactive Power scale factor	2	0	9	1	30211
Rph Apparent Power scale factor	2	0	9	1	30212
Yph Apparent Power scale factor	2	0	9	1	30213
Bph Apparent Power scale factor	2	0	9	1	30214

Total Active Power scale factor	2	0	9	1	30215
Total Reactive Power scale factor	2	0	9	1	30216
Total Apparent Power scale factor	2	0	9	1	30217
Total Max Active Power scale factor	2	0	9	1	30218
Total Max Reactive Power scale factor	2	0	9	1	30219
Total Max Apparent Power scale factor	2	0	9	1	30220
Total Min Active Power scale factor	2	0	9	1	30221
Total Min Reactive Power scale factor	2	0	9	1	30222
Total Min Apparent Power scale factor	2	0	9	1	30223
MD Rph Active Power scale factor	2	0	9	1	30224
MD Yph Active Power scale factor	2	0	9	1	30225
MD Bph Active Power scale factor	2	0	9	1	30226
MD Rph Reactive Power scale factor	2	0	9	1	30227
MD Yph Reactive Power scale factor	2	0	9	1	30228
MD Bph Reactive Power scale factor	2	0	9	1	30229
MD Rph Apparent Power scale factor	2	0	9	1	30230
MD Yph Apparent Power scale factor	2	0	9	1	30231
MD Bph Apparent Power scale factor	2	0	9	1	30232
Rph Power Factor	2	-100	100	1/100	30233
Yph Power Factor	2	-100	100	1/100	30234
Bph Power Factor	2	-100	100	1/100	30235
System PF	2	-100	100	1/100	30236

Rph Frequency	4	0	7000	1/100	30237
Yph Frequency	4	0	7000	1/100	30239
Bph Frequency	4	0	7000	1/100	30241
Average Frequency	4	0	7000	1/100	30243
Total Active Energy	8	-2147483647	2147483647	1/1000	30245
Total Reactive Energy	8	-2147483647	2147483647	1/1000	30249
Total Apparent Energy	8	-2147483647	2147483647	1/1000	30253
Total Active Energy Scale Factor	2	0	9	1	30257
Total Reactive Energy Scale Factor	2	0	9	1	30258
Total Apparent Energy Scale Factor	2	0	9	1	30259
MD Active Power	4	-2147483647	2147483647	1/100	30260
MD Reactive Power	4	-2147483647	2147483647	1/100	30262
MD Apparent Power	4	-2147483647	2147483647	1/100	30264
MD Active Power Scale Factor	2	0	9	1	30266
MD Reactive Power Scale Factor	2	0	9	1	30267
MD Apparent Power Scale Factor	2	0	9	1	30268
THDIr	2	0	1000	1/10	30269
THDIy	2	0	1000	1/10	30270
THDIb	2	0	1000	1/10	30271
THDI (System THD)	2	0	1000	1/10	30272
THDVr	2	0	1000	1/10	30273
THDVy	2	0	1000	1/10	30274
THDVb	2	0	1000	1/10	30275
THDV (System THD)	2	0	1000	1/10	30276
HDIr1	2	0	1000	1/10	30277
HDIr2	2	0	1000	1/10	30278
HDIr3	2	0	1000	1/10	30279

HDIr4	2	0	1000	1/10	30280
HDIr5	2	0	1000	1/10	30281
HDIr6	2	0	1000	1/10	30282
HDIr7	2	0	1000	1/10	30283
HDIr8	2	0	1000	1/10	30284
HDIr9	2	0	1000	1/10	30285
HDIr10	2	0	1000	1/10	30286
HDIr11	2	0	1000	1/10	30287
HDIr12	2	0	1000	1/10	30288
HDIr13	2	0	1000	1/10	30289
HDIr14	2	0	1000	1/10	30290
HDIr15	2	0	1000	1/10	30291
HDIr16	2	0	1000	1/10	30292
HDIr17	2	0	1000	1/10	30293
HDIr18	2	0	1000	1/10	30294
HDIr19	2	0	1000	1/10	30295
HDIr20	2	0	1000	1/10	30296
HDIr21	2	0	1000	1/10	30297
HDIr22	2	0	1000	1/10	30298
HDIr23	2	0	1000	1/10	30299
HDIr24	2	0	1000	1/10	30300
HDIr25	2	0	1000	1/10	30301
HDIy1	2	0	1000	1/10	30302
HDIy2	2	0	1000	1/10	30303
HDIy3	2	0	1000	1/10	30304
HDIy4	2	0	1000	1/10	30305
HDIy5	2	0	1000	1/10	30306
HDIy6	2	0	1000	1/10	30307
HDIy7	2	0	1000	1/10	30308

HDIy8	2	0	1000	1/10	30309
HDIy9	2	0	1000	1/10	30310
HDIy10	2	0	1000	1/10	30311
HDIy11	2	0	1000	1/10	30312
HDIy12	2	0	1000	1/10	30313
HDIy13	2	0	1000	1/10	30314
HDIy14	2	0	1000	1/10	30315
HDIy15	2	0	1000	1/10	30316
HDIy16	2	0	1000	1/10	30317
HDIy17	2	0	1000	1/10	30318
HDIy18	2	0	1000	1/10	30319
HDIy19	2	0	1000	1/10	30320
HDIy20	2	0	1000	1/10	30321
HDIy21	2	0	1000	1/10	30322
HDIy22	2	0	1000	1/10	30323
HDIy23	2	0	1000	1/10	30324
HDIy24	2	0	1000	1/10	30325
HDIy25	2	0	1000	1/10	30326
HDIb1	2	0	1000	1/10	30327
HDIb2	2	0	1000	1/10	30328
HDIb3	2	0	1000	1/10	30329
HDIb4	2	0	1000	1/10	30330
HDIb5	2	0	1000	1/10	30331
HDIb6	2	0	1000	1/10	30332
HDIb7	2	0	1000	1/10	30333
HDIb8	2	0	1000	1/10	30334
HDIb9	2	0	1000	1/10	30335
HDIb10	2	0	1000	1/10	30336
HDIb11	2	0	1000	1/10	30337

HDIb12	2	0	1000	1/10	30338
HDIb13	2	0	1000	1/10	30339
HDIb14	2	0	1000	1/10	30340
HDIb15	2	0	1000	1/10	30341
HDIb16	2	0	1000	1/10	30342
HDIb17	2	0	1000	1/10	30343
HDIb18	2	0	1000	1/10	30344
HDIb19	2	0	1000	1/10	30345
HDIb20	2	0	1000	1/10	30346
HDIb21	2	0	1000	1/10	30347
HDIb22	2	0	1000	1/10	30348
HDIb23	2	0	1000	1/10	30349
HDIb24	2	0	1000	1/10	30350
HDIb25	2	0	1000	1/10	30351
HDVr1	2	0	1000	1/10	30352
HDVr2	2	0	1000	1/10	30353
HDVr3	2	0	1000	1/10	30354
HDVr4	2	0	1000	1/10	30355
HDVr5	2	0	1000	1/10	30356
HDVr6	2	0	1000	1/10	30357
HDVr7	2	0	1000	1/10	30358
HDVr8	2	0	1000	1/10	30359
HDVr9	2	0	1000	1/10	30360
HDVr10	2	0	1000	1/10	30361
HDVr11	2	0	1000	1/10	30362
HDVr12	2	0	1000	1/10	30363
HDVr13	2	0	1000	1/10	30364
HDVr14	2	0	1000	1/10	30365
HDVr15	2	0	1000	1/10	30366

HDVr16	2	0	1000	1/10	30367
HDVr17	2	0	1000	1/10	30368
HDVr18	2	0	1000	1/10	30369
HDVr19	2	0	1000	1/10	30370
HDVr20	2	0	1000	1/10	30371
HDVr21	2	0	1000	1/10	30372
HDVr22	2	0	1000	1/10	30373
HDVr23	2	0	1000	1/10	30374
HDVr24	2	0	1000	1/10	30375
HDVr25	2	0	1000	1/10	30376
HDVy1	2	0	1000	1/10	30377
HDVy2	2	0	1000	1/10	30378
HDVy3	2	0	1000	1/10	30379
HDVy4	2	0	1000	1/10	30380
HDVy5	2	0	1000	1/10	30381
HDVy6	2	0	1000	1/10	30382
HDVy7	2	0	1000	1/10	30383
HDVy8	2	0	1000	1/10	30384
HDVy9	2	0	1000	1/10	30385
HDVy10	2	0	1000	1/10	30386
HDVy11	2	0	1000	1/10	30387
HDVy12	2	0	1000	1/10	30388
HDVy13	2	0	1000	1/10	30389
HDVy14	2	0	1000	1/10	30390
HDVy15	2	0	1000	1/10	30391
HDVy16	2	0	1000	1/10	30392
HDVy17	2	0	1000	1/10	30393
HDVy18	2	0	1000	1/10	30394
HDVy19	2	0	1000	1/10	30395

HDVy20	2	0	1000	1/10	30396
HDVy21	2	0	1000	1/10	30397
HDVy22	2	0	1000	1/10	30398
HDVy23	2	0	1000	1/10	30399
HDVy24	2	0	1000	1/10	30400
HDVy25	2	0	1000	1/10	30401
HDVb1	2	0	1000	1/10	30402
HDVb2	2	0	1000	1/10	30403
HDVb3	2	0	1000	1/10	30404
HDVb4	2	0	1000	1/10	30405
HDVb5	2	0	1000	1/10	30406
HDVb6	2	0	1000	1/10	30407
HDVb7	2	0	1000	1/10	30408
HDVb8	2	0	1000	1/10	30409
HDVb9	2	0	1000	1/10	30410
HDVb10	2	0	1000	1/10	30411
HDVb11	2	0	1000	1/10	30412
HDVb12	2	0	1000	1/10	30413
HDVb13	2	0	1000	1/10	30414
HDVb14	2	0	1000	1/10	30415
HDVb15	2	0	1000	1/10	30416
HDVb16	2	0	1000	1/10	30417
HDVb17	2	0	1000	1/10	30418
HDVb18	2	0	1000	1/10	30419
HDVb19	2	0	1000	1/10	30420
HDVb20	2	0	1000	1/10	30421
HDVb21	2	0	1000	1/10	30422
HDVb22	2	0	1000	1/10	30423
HDVb23	2	0	1000	1/10	30424

HDVb24	2	0	1000	1/10	30425
HDVb25	2	0	1000	1/10	30426
Current Hour	4	0	99999	1	30427
Current minute	2	0	59	1	30429
Thermal Theta R	4	0	10000	1/100	30430
Thermal Theta Y	4	0	10000	1/100	30432
Thermal Theta B	4	0	10000	1/100	30434

Profibus Communication

Profibus DPV0

Table A-5: Profibus DPV0

Attribute Name	Size (bytes)	Offset	Offset Hex	Multiplier	Type
Module 1					
IOC Stage1 Phase Trip	0 .0	0	0	1	Protection
IOC Stage2 Phase Trip	0.1		0		
IOC Stage1 neutral Trip	0.2		0		
IOC Stage2 neutral Trip	0.3		0		
IOC Stage1 Ground Trip	0.4		0		
IOC Stage2 Ground Trip	0.5		0		
IOC Stage1 NegSeq Phase Trip	0.6		0		
IOC Stage2 NegSeq Phase Trip	0.7		0		
TOC Stage1 Phase Trip	0 .0	1	1	1	Protection
TOC Stage2 Phase Trip	0.1		0		
TOC Stage1 neutral Trip	0.2		0		
TOC Stage2 neutral Trip	0.3		0		
TOC Stage1 Ground Trip	0.4		0		
TOC Stage2 Ground Trip	0.5		0		
TOC Stage1 NegSeq Phase Trip	0.6		0		
TOC Stage2 NegSeq Phase Trip	0.7		0		
TOC Stage1 Sensitive Ground Trip	0 .0	2	2	1	Protection
Thermal Overload R Phase Trip	0.1		0		
Under Current Stage1 Phase Trip	0.2		0		
Breaker Arcing phaseTrip	0.3		0		
Breaker Re-strike Stage1 Rphase Trip	0.4		0		
Breaker Failure Re-trip Ground Trip	0.5		0		
AR lockout	0.6		0		

Over Voltage Stage1 phase Trip	0.7		0		
Over Voltage Stage2 phase Trip	0 .0	3	3	1	Protection
Under Voltagr Stage1 phase Trip	0.1		0		
Under Voltagr Stage2 phase Trip	0.2		0		
Res Over Voltage Stage 1 Neutral Trip	0.3		0		
NEG SEQ Over Voltage Stage1 Phase Trip	0.4		0		
Under frequency Stage1 phase Trip	0.5		0		
Over frequency Stage1 phase Trip	0.6		0		
AUX Over Voltage	0.7		0		
AUX Under Voltage	0 .0	4	4	1	Protection
ZSI Gnd- Trip	0.1		0		
ZSI ST- Trip	0.2		0		
DIRECTIONAL IOC FORWARD Phase STAGE 1_Trip	0.3		0		
DIRECTIONAL IOC REVERSE Phase STAGE 1_Trip	0.4		0		
DIRECTIONAL IOC NEUTRAL STAGE1 FORWARD_Trip	0.5		0		
DIRECTIONAL IOC GROUND STAGE1 FORWARD_Trip	0.6		0		
DIRECTIONAL TOC FORWARD Phase STAGE 1_Trip	0.7		0		
DIRECTIONAL TOC REVERSE Phase STAGE 1_Trip	0 .0	5	5	1	Protection
DIRECTIONAL TOC NEUTRAL STAGE1 FORWARD_Trip	0.1		0		
DIRECTIONAL TOC GROUND STAGE1 FORWARD_Trip	0.2		0		
Over Power Stage1 Phase Trip	0.3		0		
Rev Power Stage1 Phase Trip	0.4		0		
Power Factor Stage1 Phase Trip	0.5		0		
Phase Seq Monitoring_ Trip	0.6		0		

Freq Gradient stage 1 _ Trip	0.7		0		
VT Fuse - Trip	0 .0	6	6	1	Protection
Any Major Error	1	7	7	1	Watchdog
Total Active Power Scaling Factor	1	8	8	1	Scaling factors
MD Active Power Scaling Factor	1	9	9	1	
MD Reactive Power Scaling Factor	1	10	A	1	
Total Active Energy Scaling Factor	1	11	B	1	
DI status (DI1-DI16)	2	12	C	1	Status
DI status (DI7-DI27)	2	14	E	1	
DO Status (DO17-DO21)	2	16	10	1	
DO Status (DO1-DO16)	2	18	12	1	
CPU DIDO Settings	2	20	14	1	
CPU DIDO Status	2	22	16	1	
System PF	2	24	18	1/100	Metering
THDI (System THD)	2	26	1A	1/10	
THDV (System THD)	2	28	1C	1/10	
Rph RMS Current	4	30	1E	1/1000	
Yph RMS Current	4	34	22	1/1000	
Bph RMS Current	4	38	26	1/1000	
Nph/SEF RMS Current	4	42	2A	1/1000	
Gph RMS Current	4	46	2E	1/1000	
Rph RMS Voltage	4	50	32	1/100	
Yph RMS Voltage	4	54	36	1/100	
Bph RMS Voltage	4	58	3A	1/100	
Sync RMS Voltage	4	62	3E	1/100	
Total Active Power	4	66	42	1/100	
Average Frequency	4	70	46	1/100	
MD Active Power	4	74	4A	1/100	
MD Reactive Power	4	78	4E	1/100	

Total Active Energy	8	82	52	1/1000	
Module 2					
Protection Byte 0	1	0	0	1	Protection
Protection Byte 1	1	1	1	1	
Protection Byte 2	1	2	2	1	
Protection Byte 3	1	3	3	1	
Protection Byte 4	1	4	4	1	
Protection Byte 5	1	5	5	1	
Any Major Error	1	6	6	1	Watchdog
Total Active Power Scaling Factor	1	7	7	1	Scaling factor
Total Active Energy Scaling Factor	1	8	8	1	
DI status (DI1-DI16)	2	9	9	1	Status
DO Status (DO1-DO16)	2	11	B	1	
System PF	2	13	D	1/100	Metering
THDI (System THD)	2	15	F	1/10	
THDV (System THD)	2	17	11	1/10	
CPU DIDO Settings	2	19	13	1	
CPU DIDO Status	2	21	15	1	
Total Active Power	4	23	17	1/100	
Average Frequency	4	27	1B	1/100	
Average Current	4	31	1F	1/1000	
RYBph Average RMS Voltage	4	35	23	1/100	
Total Active Energy	8	39	27	1/1000	
Module 3					
Protection Byte 0	1	0	0	1	Protections
Protection Byte 1	1	1	1	1	
Protection Byte 2	1	2	2	1	
Any Major Error	1	3	3	1	Watchdog
Total Active Power Scaling Factor	1	4	4	1	Scaling factor

DI status (DI1-DI16)	2	5	5	1	status
DO Status (DO1-DO16)	2	7	7	1	
System PF	2	9	9	1/100	Metering
THDI (System THD)	2	11	B	1/10	
CPU DIDO Settings	2	13	D	1	
CPU DIDO Status	2	15	F	1	
Total Active Power	4	17	11	1/100	
Average Current	4	21	15	1/1000	
Module 4					
Protection Byte 0	1	0	0	1	Protections
Any Major Error	1	1	1	1	watchdog
DI status (DI1-DI16)	2	2	2	1	Status
DO Status (DO1-DO16)	2	4	4	1	
THDI (System THD)	2	6	6	1/10	Metering
CPU DIDO Settings	2	8	8	1	
CPU DIDO Status	2	10	A	1	
Average Current	4	12	C	1/1000	
Module 5					
CPU DIDO Settings	2	0	0	1	Status
CPU DIDO Status	2	2	2	1	
Average Current	4	4	4	1/1000	Metering
Module 6					
CPU DIDO Settings	2	0	0	1	status
CPU DIDO Status	2	2	2	1	
Module 7					
CPU DIDO Status	2	0	0	1	status

Output data

Parameter	Value	Set the bit in command as 1

Commands byte	0.0	ON
	0.1	OFF
	0.2	RESET
	0.3	Reserved
	0.4	Reserved
	0.5	Reserved
	0.6	Reserved
	0.7	Reserved

IEC 61850 Logical Nodes

Logical Nodes for Metering

Table A-6: Logical nodes for Metering

Logical Node	Attribute Name	Description
METMMTR1	supWh.mag	Energy Real (MWh) Supply direction flows toward Bus Bar
METMMTR1	supVArh.mag	Energy Reactive(Mvarh) Supply direction towards Bus Bar
METMMTR1	DmdWh.mag	Energy Real(MWh) Demand direction flows away from Bus Bar
METMMTR1	DmdVArh.mag	Energy Reactive(MVArh) Demand direction away from Bus Bar
METMMXU1	TotW.mag	Three Phase Real Power P Magnitude
METMMXU1	TotVAr.mag	Three Phase Reactive Power Q Magnitude
METMMXU1	TotVA.mag	Three Phase Apparent Power S Magnitude
METMMXU1	TotPF.mag	Three Phase Power Factor
METMMXU1	Hz.mag	Measured Frequency
METMMXU1	PPV.phsAB.cValmag	AB Phase voltage magnitude
METMMXU1	PPV.phsAB.cVal.ang	AB Phase voltage angle
METMMXU1	PPV.phsBC.cValmag	BC Phase voltage magnitude
METMMXU1	PPV.phsBC.cVal.ang	BC Phase voltage angle
METMMXU1	PPV.phsCA.cValmag	CA Phase voltage magnitude
METMMXU1	PPV.phsCA.cVal.ang	CA Phase voltage angle
METMMXU1	PhV.phsA.cVal.mag	A-Phase Voltage Magnitude
METMMXU1	PhV.phsA.cVal.ang	A-Phase Voltage angle
METMMXU1	PhV.phsB.cVal.mag	B-Phase Voltage Magnitude
METMMXU1	PhV.phsB.cVal.ang	B-Phase Voltage angle
METMMXU1	PhV.phsC.cVal.mag	C-Phase Voltage Magnitude
METMMXU1	PhV.phsC.cVal.ang	C-Phase Voltage angle
METMMXU1	A.phsA.cVal.mag	A-Phase Current Magnitude
METMMXU1	A.phsA.cVal.ang	A-Phase Current angle

Logical Node	Attribute Name	Description
METMMXU1	A.phsB.cVal.mag	B-Phase Current Magnitude
METMMXU1	A.phsB.cVal.ang	B-Phase Current angle
METMMXU1	A.phsC.cVal.mag	C-Phase Current Magnitude
METMMXU1	A.phsC.cVal.ang	C-Phase Current angle
METMMXU1	A.neut.cVal.mag	Neutral current magnitude
METMMXU1	A.neut.cVal.ang	Neutral current angle
METMMXU1	A.res.cVal.mag	Residual current magnitude
METMMXU1	A.res.cVal.ang	Residual current angle
METMMXU1	W.phsA.mag	A-Phase real power magnitude
METMMXU1	W.phsB.mag	B-Phase real power magnitude
METMMXU1	W.phsC.mag	C-Phase real power magnitude
METMMXU1	Var.phsA.mag	A-Phase reactive power magnitude
METMMXU1	Var.phsB.mag	B-Phase reactive power magnitude
METMMXU1	Var.phsC.mag	C-Phase reactive power magnitude
METMMXU1	VA.phsA.mag	A-phase apparent power magnitude
METMMXU1	VA.phsB.mag	B-phase apparent power magnitude
METMMXU1	VA.phsC.mag	C-phase apparent power magnitude
METMMXU1	PF.phsA.mag	A-Phase Power Factor
METMMXU1	PF.phsB.mag	B-Phase Power Factor
METMMXU1	PF.phsC.mag	C-Phase Power Factor
METMSQI1	SeqA.c1.cVal.mag	Positive Sequence Current Magnitude
METMSQI1	SeqA.c1.cVal.ang	Positive Sequence Current Angle
METMSQI1	SeqA.c2.cVal.mag	Negative Sequence Current Magnitude
METMSQI1	SeqA.c2.cVal.ang	Negative Sequence Current Angle
METMSQI1	SeqA.c3.cVal.mag	Zero Sequence Current Magnitude
METMSQI1	SeqA.c3.cVal.ang	Zero Sequence Current Angle
METMSQI1	SeqV.c1.cValmag	Positive Sequence Voltage Magnitude
METMSQI1	SeqV.c1.cValang	Positive Sequence Voltage angle

Logical Node	Attribute Name	Description
METMSQI1	SeqV.c2.cValmag	Negative Sequence Voltage Magnitude
METMSQI1	SeqV.c2.cValang	Negative Sequence Voltage angle
METMSQI1	SeqV.c3.cValmag	Zero Sequence Voltage Magnitude
METMSQI1	SeqV.c3.cValang	Zero Sequence Voltage angle
METMSQI1	MaxImbA.mag	Current Imbalance
METMSQI1	MaxImbV.mag	Voltage Imbalance
METMSTA1	AvAmps.mag	Average current magnitude
METMSTA1	MaxA.phsA.mag	A-Phase current maximum magnitude
METMSTA1	MaxA.phsB.mag	B-Phase current maximum magnitude
METMSTA1	MaxA.phsC.mag	C-Phase current maximum magnitude
METMSTA1	MaxA.neut.mag	Neutral current maximum magnitude
METMSTA1	MaxA.res.mag	Residual current maximum magnitude
METMSTA1	MinA.phsA.mag	A-Phase current minimum magnitude
METMSTA1	MinA.phsB.mag	B-Phase current minimum magnitude
METMSTA1	MinA.phsC.mag	C-Phase current minimum magnitude
METMSTA1	MinA.neut.mag	Neutral current minimum magnitude
METMSTA1	MinA.res.mag	Residual current minimum magnitude
METMSTA1	AvVolts.mag	Average voltage magnitude
METMSTA1	Maxphv.phsA.mag	A-Phase voltage maximum magnitude
METMSTA1	Maxphv.phsB.mag	B-Phase voltage maximum magnitude
METMSTA1	Maxphv.phsC.mag	C-Phase voltage maximum magnitude
METMSTA1	Minphv.phsA.mag	A-Phase voltage minimum magnitude
METMSTA1	Minphv.phsB.mag	B-Phase voltage minimum magnitude
METMSTA1	Minphv.phsC.mag	C-Phase voltage minimum magnitude
METMSTA1	MaxVA.mag	3-Phase VA maximum magnitude
METMSTA1	MinVA.mag	3-Phase VA minimum magnitude
METMSTA1	MaxW.mag	3-Phase W maximum magnitude
METMSTA1	MinW.mag	3-Phase W minimum magnitude

Logical Node	Attribute Name	Description
METMSTA1	MaxVAr.mag	3-Phase Var maximum magnitude
METMSTA1	MinVAr.mag	3-Phase Var minimum magnitude
METMHAI	HA1.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA1.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA1.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA2.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA2.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA2.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA3.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA3.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA3.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA4.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA4.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA4.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA5.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA5.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA5.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA6.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA6.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA6.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA7.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA7.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA7.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA8.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA8.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA8.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA9.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA9.phsB.cVal.mag	B-Phase Current Harmonics

Logical Node	Attribute Name	Description
METMHAI	HA9.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA10.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA10.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA10.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA11.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA11.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA11.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA12.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA12.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA12.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA13.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA13.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA13.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA14.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA14.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA14.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA15.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA15.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA15.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA16.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA16.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA16.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA17.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA17.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA17.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA18.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA18.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA18.phsC.cVal.mag	C-Phase Current Harmonics

Logical Node	Attribute Name	Description
METMHAI	HA19.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA19.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA19.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA20.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA20.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA20.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA21.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA21.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA21.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA22.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA22.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA22.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA23.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA23.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA23.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA24.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA24.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA24.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HA25.phsA.cVal.mag	A-Phase Current Harmonics
METMHAI	HA25.phsB.cVal.mag	B-Phase Current Harmonics
METMHAI	HA25.phsC.cVal.mag	C-Phase Current Harmonics
METMHAI	HV1.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV1.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV1.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV2.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV2.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV2.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV3.phsA.cVal.mag	A-Phase Voltage Harmonics

Logical Node	Attribute Name	Description
METMHAI	HV3.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV3.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV4.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV4.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV4.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV5.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV5.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV5.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV6.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV6.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV6.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV7.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV7.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV7.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV8.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV8.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV8.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV9.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV9.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV9.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV10.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV10.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV10.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV11.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV11.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV11.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV12.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV12.phsB.cVal.mag	B-Phase Voltage Harmonics

Logical Node	Attribute Name	Description
METMHAI	HV12.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV13.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV13.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV13.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV14.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV14.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV14.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV15.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV15.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV15.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV16.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV16.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV16.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV17.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV17.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV17.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV18.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV18.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV18.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV19.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV19.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV19.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV20.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV20.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV20.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV21.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV21.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV21.phsC.cVal.mag	C-Phase Voltage Harmonics

Logical Node	Attribute Name	Description
METMHAI	HV22.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV22.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV22.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV23.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV23.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV23.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV24.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV24.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV24.phsC.cVal.mag	C-Phase Voltage Harmonics
METMHAI	HV25.phsA.cVal.mag	A-Phase Voltage Harmonics
METMHAI	HV25.phsB.cVal.mag	B-Phase Voltage Harmonics
METMHAI	HV25.phsC.cVal.mag	C-Phase Voltage Harmonics

Logical Nodes For Protections

Table A-7: Logical nodes for Protection

Logical Node	Attribute Name	Description
PPIOC1	Str.general (50P1P)	IOC Phase Stage1 Alarm
PPIOC1	Op.general (50P1T)	IOC Phase Stage1 Trip
PPIOC2	Str.general (50P2P)	IOC Phase Stage2 Alarm
PPIOC2	Op.general (50P2T)	IOC Phase Stage2 Trip
PPIOC3	Str.general (50P3P)	IOC Phase Stage3 Alarm
PPIOC3	Op.general (50P3T)	IOC Phase Stage3 Trip
PPIOC4	Str.general (50P4P)	IOC Phase Stage4 Alarm
PPIOC4	Op.general (50P4T)	IOC Phase Stage4 Trip
NPIOC1	Str.general (50N1P)	IOC Stage1 N Phase Alarm
NPIOC1	Op.general (50N1T)	IOC Stage1 N Phase Trip
NPIOC2	Str.general (50N2P)	IOC Stage2 N Phase Alarm
NPIOC2	Op.general (50N2T)	IOC Stage2 N Phase Trip

Logical Node	Attribute Name	Description
NPIOC3	Str.general (50N3P)	IOC Stage3 N Phase Alarm
NPIOC3	Op.general (50N3T)	IOC Stage3 N Phase Trip
NPIOC4	Str.general (50N4P)	IOC Stage4 N Phase Alarm
NPIOC4	Op.general (50N4T)	IOC Stage4 N Phase Trip
GPIOC1	Str.general (50G1P)	IOC Stage1 G Phase Alarm
GPIOC1	Op.general (50G1T)	IOC Stage1 G Phase Trip
GPIOC2	Str.general (50G2P)	IOC Stage2 G Phase Alarm
GPIOC2	Op.general (50G2T)	IOC Stage2 G Phase Trip
GPIOC3	Str.general (50G3P)	IOC Stage3 G Phase Alarm
GPIOC3	Op.general (50G3T)	IOC Stage3 G Phase Trip
GPIOC4	Str.general (50G4P)	IOC Stage4 G Phase Alarm
GPIOC4	Op.general (50G4T)	IOC Stage4 G Phase Trip
QPIOC1	Str.general (50Q1P)	IOC Stage1 NegSeq Phase Alarm
QPIOC1	Op.general (50Q1T)	IOC Stage1 NegSeq Phase Trip
QPIOC2	Str.general (50Q2P)	IOC Stage2 NegSeq Phase Alarm
QPIOC2	Op.general (50Q2T)	IOC Stage2 NegSeq Phase Trip
QPIOC3	Str.general (50Q3P)	IOC Stage3 NegSeq Phase Alarm
QPIOC3	Op.general (50Q3T)	IOC Stage3 NegSeq Phase Trip
QPIOC4	Str.general (50Q4P)	IOC Stage4 NegSeq Phase Alarm
QPIOC4	Op.general (50Q4T)	IOC Stage4 NegSeq Phase Trip
SPIOC1	Str.general (50S1P)	IOC Stage1 Sensitive Ground Alarm
SPIOC1	Op.general (50S1T)	IOC Stage1 Sensitive Ground Trip
SPIOC2	Str.general (50S2P)	IOC Stage2 Sensitive Ground Alarm
SPIOC2	Op.general (50S2T)	IOC Stage2 Sensitive Ground Trip
SPIOC3	Str.general (50S3P)	IOC Stage3 Sensitive Ground Alarm
SPIOC3	Op.general (50S3T)	IOC Stage3 Sensitive Ground Trip
SPIOC4	Str.general (50S4P)	IOC Stage4 Sensitive Ground Alarm
SPIOC4	Op.general (50S4T)	IOC Stage4 Sensitive Ground Trip

Logical Node	Attribute Name	Description
PPTOC1	Str.general (51P1P)	TOC Stage1 Alarm
PPTOC1	Op.general (51P1T)	TOC Stage1 Trip
PPTOC2	Str.general (51P2P)	TOC Stage2 Alarm
PPTOC2	Op.general (51P2T)	TOC Stage2 Trip
PPTOC3	Str.general (51P3P)	TOC Stage3 Alarm
PPTOC3	Op.general (51P3T)	TOC Stage3 Trip
PPTOC4	Str.general (51P4P)	TOC Stage4 Alarm
PPTOC4	Op.general (51P4T)	TOC Stage4 Trip
GPTOC1	Str.general (51G1P)	TOC Stage1 G Phase Alarm
GPTOC1	Op.general (51G1T)	TOC Stage1 G Phase Trip
GPTOC2	Str.general (51G2P)	TOC Stage2 G Phase Alarm
GPTOC2	Op.general (51G2T)	TOC Stage2 G Phase Trip
GPTOC3	Str.general (51G3P)	TOC Stage3 G Phase Alarm
GPTOC3	Op.general (51G3T)	TOC Stage3 G Phase Trip
GPTOC4	Str.general (51G4P)	TOC Stage4 G Phase Alarm
GPTOC4	Op.general (51G4T)	TOC Stage4 G Phase Trip
NPTOC1	Str.general (51N1P)	TOC Stage1 N Phase Alarm
NPTOC1	Op.general (51N1T)	TOC Stage1 N Phase Trip
NPTOC2	Str.general (51N2P)	TOC Stage2 N Phase Alarm
NPTOC2	Op.general (51N2T)	TOC Stage2 N Phase Trip
NPTOC3	Str.general (51N3P)	TOC Stage3 N Phase Alarm
NPTOC3	Op.general (51N3T)	TOC Stage3 N Phase Trip
NPTOC4	Str.general (51N4P)	TOC Stage4 N Phase Alarm
NPTOC4	Op.general (51N4T)	TOC Stage4 N Phase Trip
QPTOC1	Str.general (51Q1P)	TOC Stage1 NegSeq Phase Alarm
QPTOC1	Op.general (51Q1T)	TOC Stage1 NegSeq Phase Trip
QPTOC2	Str.general (51Q2P)	TOC Stage2 NegSeq Phase Alarm
QPTOC2	Op.general (51Q2T)	TOC Stage2 NegSeq Phase Trip

Logical Node	Attribute Name	Description
QPTOC3	Str.general (51Q3P)	TOC Stage3 NegSeq Phase Alarm
QPTOC3	Op.general (51Q3T)	TOC Stage3 NegSeq Phase Trip
QPTOC4	Str.general (51Q4P)	TOC Stage4 NegSeq Phase Alarm
QPTOC4	Op.general (51Q4T)	TOC Stage4 NegSeq Phase Trip
SPTOC1	Str.general (51S1P)	TOC Stage1 Sensitive Ground Alarm
SPTOC1	Op.general (51S1T)	TOC Stage1 Sensitive Ground Trip
SPTOC2	Str.general (51S2P)	TOC Stage2 Sensitive Ground Alarm
SPTOC2	Op.general (51S2T)	TOC Stage2 Sensitive Ground Trip
SPTOC3	Str.general (51S3P)	TOC Stage3 Sensitive Ground Alarm
SPTOC3	Op.general (51S3T)	TOC Stage3 Sensitive Ground Trip
SPTOC4	Str.general (51S4P)	TOC Stage4 Sensitive Ground Alarm
SPTOC4	Op.general (51S4T)	TOC Stage4 Sensitive Ground Trip
PPTUV	Str.general (27P)	Under Current Stage1 Phase Alarm
PPTUV	Op.general (27T)	Under Current Stage1 Phase Trip
NPTUV	Str.general (27P)	Under current Stage1 N Phase Alarm
NPTUV	Op.general (27T)	Under current Stage1 N Phase Trip
PDIF	Str.general (87P)	REF Alarm
PDIF	Op.general (87T)	REF Trip
PTTR	Str.general (49P)	Thermal Overload Phase Alarm
PTTR	Op.general (49T)	Thermal Overload Phase Trip
PTUV1	Str.general (27P1P)	Under Voltagr Stage 1 phase Alarm
PTUV1	Op.general (27P1T)	Under Voltagr Stage 1 phase Trip
PTUV2	Str.general (27P2P)	Under Voltagr Stage 2 phase Alarm
PTUV2	Op.general (27P2T)	Under Voltagr Stage 2 phase Trip
PTUV3	Str.general (27P3P)	Under Voltagr Stage 3 phase Alarm
PTUV3	Op.general (27P3T)	Under Voltagr Stage 3 phase Trip
PTOV1	Str.general (59P1P)	Over Voltage Stage 1 phase Alarm
PTOV1	Op.general (59P1T)	Over Voltage Stage 1 phase Trip

Logical Node	Attribute Name	Description
PTOV2	Str.general (59P2P)	Over Voltage Stage 2 phase Alarm
PTOV2	Op.general (59P2T)	Over Voltage Stage 2 phase Trip
PTOV3	Str.general (59P3P)	Over Voltage Stage 3 phase Alarm
PTOV3	Op.general (59P3T)	Over Voltage Stage 3 phase Trip
RPTOV1	Str.general (59N1P)	Res Over Voltage Stage 1 Alarm
RPTOV1	Op.general (59N1T)	Res Over Voltage Stage 1 Trip
RPTOV2	Str.general (59N2P)	Res Over Voltage Stage 2 Alarm
RPTOV2	Op.general (59N2T)	Res Over Voltage Stage 2 Trip
RPTOV3	Str.general (59N3P)	Res Over Voltage Stage 3 Alarm
RPTOV3	Op.general (59N3T)	Res Over Voltage Stage 3 Trip
PQPTOV1	Str.general (59Q1P)	POS SEQ Over Voltage Stage1 Alarm
PQPTOV1	Op.general (59Q1T)	POS SEQ Over Voltage Stage1 Trip
PQPTOV2	Str.general (59Q2P)	POS SEQ Over Voltage Stage2 Alarm
PQPTOV2	Op.general (59Q2T)	POS SEQ Over Voltage Stage2 Trip
PQPTOV3	Str.general (59Q3P)	POS SEQ Over Voltage Stage3 Alarm
PQPTOV3	Op.general (59Q3T)	POS SEQ Over Voltage Stage3 Trip
NQPTOV1	Str.general (59N1P)	NEG SEQ Over Voltage Stage1 Alarm
NQPTOV1	Op.general (59N1T)	NEG SEQ Over Voltage Stage1 Trip
NQPTOV2	Str.general (59N2P)	NEG SEQ Over Voltage Stage2 Alarm
NQPTOV2	Op.general (59N2T)	NEG SEQ Over Voltage Stage2 Trip
NQPTOV3	Str.general (59N3P)	NEG SEQ Over Voltage Stage3 Alarm
NQPTOV3	Op.general (59N3T)	NEG SEQ Over Voltage Stage3 Trip
PQPTUV1	Str.general (27Q1P)	POS SEQ Under Voltage Stage1 Alarm
PQPTUV1	Op.general (27Q1T)	POS SEQ Under Voltage Stage1 Trip
PQPTUV2	Str.general (27Q2P)	POS SEQ Under Voltage Stage2 Alarm
PQPTUV2	Op.general (27Q2T)	POS SEQ Under Voltage Stage2 Trip
PQPTUV3	Str.general (27Q3P)	POS SEQ Under Voltage Stage3 Alarm
PQPTUV3	Op.general (27Q3T)	POS SEQ Under Voltage Stage3 Trip

Logical Node	Attribute Name	Description
AUXPTUV	Str.general (27AP)	AUX Under Voltage Alarm
AUXPTUV	Op.general (27AT)	AUX Under Voltage Trip
AUXPTOV	Str.general (27AP)	AUX Over Voltage Alarm
AUXPTOV	Op.general (27AT)	AUX Over Voltage Trip
PTUF1	Str.general (81U1P)	Under frequency Stage1 phase Alarm
PTUF1	Str.general (81U1P)	Under frequency Stage1 phase Trip
PTUF2	Str.general (81U2P)	Under frequency Stage2 phase Alarm
PTUF2	Op.general (81D2T)	Under frequency Stage2 phase Trip
PTUF3	Str.general (81U3P)	Under frequency Stage3 phase Alarm
PTUF3	Op.general (81U3T)	Under frequency Stage3 phase Trip
PTUF4	Str.general (81U4P)	Under frequency Stage4 phase Alarm
PTUF4	Op.general (81U4T)	Under frequency Stage4 phase Trip
PTUF5	Str.general (81U5P)	Under frequency Stage5 phase Alarm
PTUF5	Op.general (81U5T)	Under frequency Stage5 phase Trip
PTUF6	Str.general (81U6P)	Under frequency Stage6 phase Alarm
PTUF6	Op.general (81U6T)	Under frequency Stage6 phase Trip
PTOF1	Str.general (81O1P)	Over frequency Stage1 phase Alarm
PTOF1	Op.general (81O1T)	Over frequency Stage1 phase Trip
PTOF2	Str.general (81O2P)	Over frequency Stage2 phase Alarm
PTOF2	Op.general (81D2T)	Over frequency Stage2 phase Trip
PTOF3	Str.general (81O3P)	Over frequency Stage3 phase Alarm
PTOF3	Op.general (81O3T)	Over frequency Stage3 phase Trip
PTOF4	Str.general (81O4P)	Over frequency Stage4 phase Alarm
PTOF4	Op.general (81O4T)	Over frequency Stage4 phase Trip
PTOF5	Str.general (81O5P)	Over frequency Stage5 phase Alarm
PTOF5	Op.general (81O5T)	Over frequency Stage5 phase Trip
PTOF6	Str.general (81O6P)	Over frequency Stage6 phase Alarm
PTOF6	Op.general (81O6T)	Over frequency Stage6 phase Trip

Logical Node	Attribute Name	Description
DPIOC1	Str.general (67D1P)	Directional Phase IOC Stage 1 Alarm
DPIOC1	Op.general (67D1T)	Directional Phase IOC Stage 1 Trip
DPIOC2	Str.general (67D2P)	Directional Phase IOC Stage 2 Alarm
DPIOC2	Op.general (67D2T)	Directional Phase IOC Stage 2 Trip
DPTOC1	Str.general (67D1P)	Directional Phase TOC Stage 1 Alarm
DPTOC1	Op.general (67D1T)	Directional Phase TOC Stage 1 Trip
DPTOC2	Str.general (67D2P)	Directional Phase TOC Stage 2 Alarm
DPTOC2	Op.general (67D2T)	Directional Phase TOC Stage 2 Trip
DNPIOC1	Str.general (67DN1P)	Directional Phase IOC Stage 1 Alarm
DNPIOC1	Op.general (67DN1T)	Directional Phase IOC Stage 1 Trip
DNPIOC2	Str.general (67DN2P)	Directional Phase IOC Stage 2 Alarm
DNPIOC2	Op.general (67DN2T)	Directional Phase IOC Stage 2 Trip
DNPTOC1	Str.general (67DNT1P)	Directional Phase TOC Stage 1 Alarm
DNPTOC1	Op.general (67DNT1T)	Directional Phase TOC Stage 1 Trip
DNPTOC2	Str.general (67DNT2P)	Directional Phase IOC Stage 2 Alarm
DNPTOC2	Op.general (67DNT2T)	Directional Phase IOC Stage 2 Trip
DGPIOC1	Str.general (67DG1P)	Directional Phase IOC Stage 1 Alarm
DGPIOC1	Op.general (67DG1T)	Directional Phase IOC Stage 1 Trip
DGPIOC2	Str.general (67DG2P)	Directional Phase IOC Stage 2 Alarm
DGPIOC2	Op.general (67DG2T)	Directional Phase IOC Stage 2 Trip
DGPTOC1	Str.general (67DGT1P)	Directional Phase TOC Stage 1 Alarm
DGPTOC1	Op.general (67DGT1T)	Directional Phase TOC Stage 1 Trip
DGPTOC2	Str.general (67DGT2P)	Directional Phase TOC Stage 2 Alarm
DGPTOC2	Str.general (67DGT2P)	Directional Phase TOC Stage 2 Trip
PDOP1	Str.general (37P1P)	Over Power Stage1 Phase Alarm
PDOP1	Str.general (37P1P)	Over Power Stage1 Phase Trip
PDOP2	Str.general (37P2P)	Over Power Stage2 Phase Alarm
PDOP2	Op.general (37P2T)	Over Power Stage2 Phase Trip

Logical Node	Attribute Name	Description
PDOP3	Str.general (37P3P)	Over Power Stage3 Phase Alarm
PDOP3	Op.general (37P3T)	Over Power Stage3 Phase Trip
PDOP4	Str.general (37P4P)	Over Power Stage4 Phase Alarm
PDOP4	Op.general (37P4T)	Over Power Stage4 Phase Trip
RPODP	Str.general (37PRP)	Rev Power Stage1 Phase Alarm
RPODP	Op.general (37PRT)	Rev Power Stage1 Phase Trip
POPF	Str.general (55OP)	Lead Power Factor Stage1 Phase Alarm
POPF	Op.general (55OT)	Lead Power Factor Stage1 Phase Trip
PUPF	Str.general (55UP)	Lag Power Factor Stage1 Phase Alarm
PUPF	Op.general (55UT)	Lag Power Factor Stage1 Phase Trip
RREC	Str.general (RRECP)	AR reclose Alarm
RREC	Op.general (RRECT)	AR reclose Trip
RBRF	Str.general (RBF)	Breaker Failure Re-trip Ground Alarm
RSYN	Str.general (RYN)	Sync Stage 1 Alarm

Logical Nodes For Control

Table A-8: Logical nodes for Control

Logical Node	Attribute Name	Description
RBGGIO1	SPC01.StVal	Remote Input1
RBGGIO1	SPC02.StVal	Remote Input2
RBGGIO1	SPC03.StVal	Remote Input3
RBGGIO1	SPC04.StVal	Remote Input4
RBGGIO1	SPC05.StVal	Remote Input5
RBGGIO1	SPC06.StVal	Remote Input6
RBGGIO1	SPC07.StVal	Remote Input7
RBGGIO1	SPC08.StVal	Remote Input8
RBGGIO1	SPC01.ctlVal	Remote Output1

Logical Node	Attribute Name	Description
RBGGIO1	SPC02.ctlVal	Remote Output2
RBGGIO1	SPC03.ctlVal	Remote Output3
RBGGIO1	SPC04.ctlVal	Remote Output4
RBGGIO1	SPC05.ctlVal	Remote Output5
RBGGIO1	SPC06.ctlVal	Remote Output6
RBGGIO1	SPC07.ctlVal	Remote Output7
RBGGIO1	SPC08.ctlVal	Remote Output8
RBGGIO2	SPC01.StVal	Remote Input9
RBGGIO2	SPC02.StVal	Remote Input10
RBGGIO2	SPC03.StVal	Remote Input11
RBGGIO2	SPC04.StVal	Remote Input12
RBGGIO2	SPC05.StVal	Remote Input13
RBGGIO2	SPC06.StVal	Remote Input14
RBGGIO2	SPC07.StVal	Remote Input15
RBGGIO2	SPC08.StVal	Remote Input16
RBGGIO2	SPC01.ctlVal	Remote Output9
RBGGIO2	SPC02.ctlVal	Remote Output10
RBGGIO2	SPC03.ctlVal	Remote Output11
RBGGIO2	SPC04.ctlVal	Remote Output12
RBGGIO2	SPC05.ctlVal	Remote Output13
RBGGIO2	SPC06.ctlVal	Remote Output14
RBGGIO2	SPC07.ctlVal	Remote Output15
RBGGIO2	SPC08.ctlVal	Remote Output16
RBGGIO3	SPC01.StVal	Remote Input17
RBGGIO3	SPC02.StVal	Remote Input18
RBGGIO3	SPC03.StVal	Remote Input19
RBGGIO3	SPC04.StVal	Remote Input20
RBGGIO3	SPC05.StVal	Remote Input21

Logical Node	Attribute Name	Description
RBGGIO3	SPC06.StVal	Remote Input22
RBGGIO3	SPC07.StVal	Remote Input23
RBGGIO3	SPC08.StVal	Remote Input24
RBGGIO3	SPC01.ctlVal	Remote Output17
RBGGIO3	SPC02.ctlVal	Remote Output18
RBGGIO3	SPC03.ctlVal	Remote Output19
RBGGIO3	SPC04.ctlVal	Remote Output20
RBGGIO3	SPC05.ctlVal	Remote Output21
RBGGIO3	SPC06.ctlVal	Remote Output22
RBGGIO3	SPC07.ctlVal	Remote Output23
RBGGIO3	SPC08.ctlVal	Remote Output24
RBGGIO4	SPC01.StVal	Remote Input25
RBGGIO4	SPC02.StVal	Remote Input26
RBGGIO4	SPC03.StVal	Remote Input27
RBGGIO4	SPC04.StVal	Remote Input28
RBGGIO4	SPC05.StVal	Remote Input29
RBGGIO4	SPC06.StVal	Remote Input30
RBGGIO4	SPC07.StVal	Remote Input31
RBGGIO4	SPC08.StVal	Remote Input32
RBGGIO4	SPC01.ctlVal	Remote Output25
RBGGIO4	SPC02.ctlVal	Remote Output26
RBGGIO4	SPC03.ctlVal	Remote Output27
RBGGIO4	SPC04.ctlVal	Remote Output28
RBGGIO4	SPC05.ctlVal	Remote Output29
RBGGIO4	SPC06.ctlVal	Remote Output30
RBGGIO4	SPC07.ctlVal	Remote Output31
RBGGIO4	SPC08.ctlVal	Remote Output32

Logical Nodes For Annunciation

Table A-9: Logical nodes for Annunciation

Logical Node	Attribute Name	Description
INAGGIO1	Ind01	Contact Input1
INAGGIO1	Ind02	Contact Input2
INAGGIO1	Ind03	Contact Input3
INAGGIO1	Ind04	Contact Input4
INAGGIO1	Ind05	Contact Input5
INAGGIO1	Ind06	Contact Input6
INAGGIO1	Ind07	Contact Input7
INAGGIO1	Ind08	Contact Input8
INAGGIO1	Ind09	Contact Input9
INAGGIO1	Ind10	Contact Input10
INAGGIO1	Ind11	Contact Input11
INAGGIO1	Ind12	Contact Input12
INAGGIO1	Ind13	Contact Input13
INAGGIO1	Ind14	Contact Input14
INAGGIO1	Ind15	Contact Input15
INAGGIO1	Ind16	Contact Input16
INAGGIO1	Ind17	Contact Input17
INAGGIO1	Ind18	Contact Input18
INAGGIO1	Ind19	Contact Input19
INAGGIO1	Ind20	Contact Input20
INAGGIO1	Ind21	Contact Input21
INAGGIO1	Ind22	Contact Input22
INAGGIO1	Ind23	Contact Input23
INAGGIO1	Ind24	Contact Input24
INAGGIO1	Ind25	Contact Input25
INAGGIO1	Ind26	Contact Input26

Logical Node	Attribute Name	Description
INAGGIO1	Ind27	Contact Input27
OUTAGGIO2	Ind01	Contact Output1
OUTAGGIO2	Ind02	Contact Output2
OUTAGGIO2	Ind03	Contact Output3
OUTAGGIO2	Ind04	Contact Output4
OUTAGGIO2	Ind05	Contact Output5
OUTAGGIO2	Ind06	Contact Output6
OUTAGGIO2	Ind07	Contact Output7
OUTAGGIO2	Ind08	Contact Output8
OUTAGGIO2	Ind09	Contact Output9
OUTAGGIO2	Ind10	Contact Output10
OUTAGGIO2	Ind11	Contact Output11
OUTAGGIO2	Ind12	Contact Output12
OUTAGGIO2	Ind13	Contact Output13
OUTAGGIO2	Ind14	Contact Output14
OUTAGGIO2	Ind15	Contact Output15
OUTAGGIO2	Ind16	Contact Output16
OUTAGGIO2	Ind17	Contact Output17
OUTAGGIO2	Ind18	Contact Output18
OUTAGGIO2	Ind19	Contact Output19
OUTAGGIO2	Ind20	Contact Output20
OUTAGGIO2	Ind21	Contact Output21
VTGGIO1	Ind01	Timer1
VTGGIO1	Ind02	Timer2
VTGGIO1	Ind03	Timer3
VTGGIO1	Ind04	Timer4
VTGGIO1	Ind05	Timer5
VTGGIO1	Ind06	Timer6

Logical Node	Attribute Name	Description
VTGGIO1	Ind07	Timer7
VTGGIO1	Ind08	Timer8
VTGGIO1	Ind09	Timer9
VTGGIO1	Ind10	Timer10
VTGGIO1	Ind11	Timer11
VTGGIO1	Ind12	Timer12
VTGGIO1	Ind13	Timer13
VTGGIO1	Ind14	Timer14
VTGGIO1	Ind15	Timer15
VTGGIO1	Ind16	Timer16
VTGGIO1	Ind17	Timer17
VTGGIO1	Ind18	Timer18
VTGGIO1	Ind19	Timer19
VTGGIO1	Ind20	Timer20
VTGGIO1	Ind21	Timer21
VTGGIO1	Ind22	Timer22
VTGGIO1	Ind23	Timer23
VTGGIO1	Ind24	Timer24
VTGGIO1	Ind25	Timer25
VTGGIO1	Ind26	Timer26
VTGGIO1	Ind27	Timer27
VTGGIO1	Ind28	Timer28
VTGGIO1	Ind29	Timer29
VTGGIO1	Ind30	Timer30
VTGGIO1	Ind31	Timer31
VTGGIO1	Ind32	Timer32
LBGGIO1	Ind01	Operate Latch1
LBGGIO1	Ind02	Operate Latch2

Logical Node	Attribute Name	Description
LBGGIO1	Ind03	Operate Latch3
LBGGIO1	Ind04	Operate Latch4
LBGGIO1	Ind05	Operate Latch5
LBGGIO1	Ind06	Operate Latch6
LBGGIO1	Ind07	Operate Latch7
LBGGIO1	Ind08	Operate Latch8
LBGGIO1	Ind09	Operate Latch9
LBGGIO1	Ind10	Operate Latch10
LBGGIO1	Ind11	Operate Latch11
LBGGIO1	Ind12	Operate Latch12
LBGGIO1	Ind13	Operate Latch13
LBGGIO1	Ind14	Operate Latch14
LBGGIO1	Ind15	Operate Latch15
LBGGIO1	Ind16	Operate Latch16
LBGGIO1	Ind17	Operate Latch17
LBGGIO1	Ind18	Operate Latch18
LBGGIO1	Ind19	Operate Latch19
LBGGIO1	Ind20	Operate Latch20
LBGGIO1	Ind21	Operate Latch21
LBGGIO1	Ind22	Operate Latch22
LBGGIO1	Ind23	Operate Latch23
LBGGIO1	Ind24	Operate Latch24
LBGGIO1	Ind25	Operate Latch25
LBGGIO1	Ind26	Operate Latch26
LBGGIO1	Ind27	Operate Latch27
LBGGIO1	Ind28	Operate Latch28
LBGGIO1	Ind29	Operate Latch29
LBGGIO1	Ind30	Operate Latch30

Logical Node	Attribute Name	Description
LBGGIO1	Ind31	Operate Latch31
LBGGIO1	Ind32	Operate Latch32
TLEDGGIO1	Ind01	LED1
TLEDGGIO1	Ind02	LED2
TLEDGGIO1	Ind03	LED3
TLEDGGIO1	Ind04	LED4
TLEDGGIO1	Ind05	LED5
TLEDGGIO1	Ind06	LED6
TLEDGGIO1	Ind07	LED7
TLEDGGIO1	Ind08	LED8
TLEDGGIO1	Ind09	LED9
TLEDGGIO1	Ind10	LED10
TLEDGGIO1	Ind11	LED11
TLEDGGIO1	Ind12	LED12
TLEDGGIO1	Ind13	LED13
TLEDGGIO1	Ind14	LED14
TLEDGGIO1	Ind15	LED15
TLEDGGIO1	Ind16	LED16
TLEDGGIO1	Ind17	LED17
TLEDGGIO1	Ind18	LED18
PBLEDGGIO1	Ind01	LED1
PBLEDGGIO1	Ind02	LED2
PBLEDGGIO1	Ind03	LED3
PBLEDGGIO1	Ind04	LED4
PBLEDGGIO1	Ind05	LED5
PBLEDGGIO1	Ind06	LED6
VBGGIO1	Ind01	Virtual Bit1
VBGGIO1	Ind02	Virtual Bit2

Logical Node	Attribute Name	Description
VBGGIO1	Ind03	Virtual Bit3
VBGGIO1	Ind04	Virtual Bit4
VBGGIO1	Ind05	Virtual Bit5
VBGGIO1	Ind06	Virtual Bit6
VBGGIO1	Ind07	Virtual Bit7
VBGGIO1	Ind08	Virtual Bit8
VBGGIO1	Ind09	Virtual Bit9
VBGGIO1	Ind10	Virtual Bit10
VBGGIO1	Ind11	Virtual Bit11
VBGGIO1	Ind12	Virtual Bit12
VBGGIO1	Ind13	Virtual Bit13
VBGGIO1	Ind14	Virtual Bit14
VBGGIO1	Ind15	Virtual Bit15
VBGGIO1	Ind16	Virtual Bit16
VBGGIO1	Ind17	Virtual Bit17
VBGGIO1	Ind18	Virtual Bit18
VBGGIO1	Ind19	Virtual Bit19
VBGGIO1	Ind20	Virtual Bit20
VBGGIO1	Ind21	Virtual Bit21
VBGGIO1	Ind22	Virtual Bit22
VBGGIO1	Ind23	Virtual Bit23
VBGGIO1	Ind24	Virtual Bit24
VBGGIO1	Ind25	Virtual Bit25
VBGGIO1	Ind26	Virtual Bit26
VBGGIO1	Ind27	Virtual Bit27
VBGGIO1	Ind28	Virtual Bit28
VBGGIO1	Ind29	Virtual Bit29
VBGGIO1	Ind30	Virtual Bit30

Logical Node	Attribute Name	Description
VBGGIO1	Ind31	Virtual Bit31
VBGGIO1	Ind32	Virtual Bit32
VBGGIO2	Ind01	Virtual Bit1
VBGGIO2	Ind02	Virtual Bit2
VBGGIO2	Ind03	Virtual Bit3
VBGGIO2	Ind04	Virtual Bit4
VBGGIO2	Ind05	Virtual Bit5
VBGGIO2	Ind06	Virtual Bit6
VBGGIO2	Ind07	Virtual Bit7
VBGGIO2	Ind08	Virtual Bit8
VBGGIO2	Ind09	Virtual Bit9
VBGGIO2	Ind10	Virtual Bit10
VBGGIO2	Ind11	Virtual Bit11
VBGGIO2	Ind12	Virtual Bit12
VBGGIO2	Ind13	Virtual Bit13
VBGGIO2	Ind14	Virtual Bit14
VBGGIO2	Ind15	Virtual Bit15
VBGGIO2	Ind16	Virtual Bit16
VBGGIO2	Ind17	Virtual Bit17
VBGGIO2	Ind18	Virtual Bit18
VBGGIO2	Ind19	Virtual Bit19
VBGGIO2	Ind20	Virtual Bit20
VBGGIO2	Ind21	Virtual Bit21
VBGGIO2	Ind22	Virtual Bit22
VBGGIO2	Ind23	Virtual Bit23
VBGGIO2	Ind24	Virtual Bit24
VBGGIO2	Ind25	Virtual Bit25
VBGGIO2	Ind26	Virtual Bit26

Logical Node	Attribute Name	Description
VBGGIO2	Ind27	Virtual Bit27
VBGGIO2	Ind28	Virtual Bit28
VBGGIO2	Ind29	Virtual Bit29
VBGGIO2	Ind30	Virtual Bit30
VBGGIO2	Ind31	Virtual Bit31
VBGGIO2	Ind32	Virtual Bit32
VBGGIO3	Ind01	Virtual Bit1
VBGGIO3	Ind02	Virtual Bit2
VBGGIO3	Ind03	Virtual Bit3
VBGGIO3	Ind04	Virtual Bit4
VBGGIO3	Ind05	Virtual Bit5
VBGGIO3	Ind06	Virtual Bit6
VBGGIO3	Ind07	Virtual Bit7
VBGGIO3	Ind08	Virtual Bit8
VBGGIO3	Ind09	Virtual Bit9
VBGGIO3	Ind10	Virtual Bit10
VBGGIO3	Ind11	Virtual Bit11
VBGGIO3	Ind12	Virtual Bit12
VBGGIO3	Ind13	Virtual Bit13
VBGGIO3	Ind14	Virtual Bit14
VBGGIO3	Ind15	Virtual Bit15
VBGGIO3	Ind16	Virtual Bit16
VBGGIO3	Ind17	Virtual Bit17
VBGGIO3	Ind18	Virtual Bit18
VBGGIO3	Ind19	Virtual Bit19
VBGGIO3	Ind20	Virtual Bit20
VBGGIO3	Ind21	Virtual Bit21
VBGGIO3	Ind22	Virtual Bit22

Logical Node	Attribute Name	Description
VBGGIO3	Ind23	Virtual Bit23
VBGGIO3	Ind24	Virtual Bit24
VBGGIO3	Ind25	Virtual Bit25
VBGGIO3	Ind26	Virtual Bit26
VBGGIO3	Ind27	Virtual Bit27
VBGGIO3	Ind28	Virtual Bit28
VBGGIO3	Ind29	Virtual Bit29
VBGGIO3	Ind30	Virtual Bit30
VBGGIO3	Ind31	Virtual Bit31
VBGGIO3	Ind32	Virtual Bit32
VBGGIO4	Ind01	Virtual Bit1
VBGGIO4	Ind02	Virtual Bit2
VBGGIO4	Ind03	Virtual Bit3
VBGGIO4	Ind04	Virtual Bit4
VBGGIO4	Ind05	Virtual Bit5
VBGGIO4	Ind06	Virtual Bit6
VBGGIO4	Ind07	Virtual Bit7
VBGGIO4	Ind08	Virtual Bit8
VBGGIO4	Ind09	Virtual Bit9
VBGGIO4	Ind10	Virtual Bit10
VBGGIO4	Ind11	Virtual Bit11
VBGGIO4	Ind12	Virtual Bit12
VBGGIO4	Ind13	Virtual Bit13
VBGGIO4	Ind14	Virtual Bit14
VBGGIO4	Ind15	Virtual Bit15
VBGGIO4	Ind16	Virtual Bit16
VBGGIO4	Ind17	Virtual Bit17
VBGGIO4	Ind18	Virtual Bit18

Logical Node	Attribute Name	Description
VBGGIO4	Ind19	Virtual Bit19
VBGGIO4	Ind20	Virtual Bit20
VBGGIO4	Ind21	Virtual Bit21
VBGGIO4	Ind22	Virtual Bit22
VBGGIO4	Ind23	Virtual Bit23
VBGGIO4	Ind24	Virtual Bit24
VBGGIO4	Ind25	Virtual Bit25
VBGGIO4	Ind26	Virtual Bit26
VBGGIO4	Ind27	Virtual Bit27
VBGGIO4	Ind28	Virtual Bit28
VBGGIO4	Ind29	Virtual Bit29
VBGGIO4	Ind30	Virtual Bit30
VBGGIO4	Ind31	Virtual Bit31
VBGGIO4	Ind32	Virtual Bit32

Annexure B

CERTIFICATES

Profibus DPV0 PNO Certificate

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Certificate

PROFIBUS Nutzerorganisation e.V. grants to

L&T – Electrical and Automation Limited
North Wing, Level-1, L&T Gate 7, Sakivihar Road, 400072 Mumbai, India

the Certificate No: **Z01779** for the PROFIBUS Device:

Model Name:	**FCOMP**
Revision:	**V1.0; SW/FW: V1.1; HW: V1.1**
GSD:	**LNT0E72.GSD, File Version: 21. August 2013**

This certificate confirms that the product has successfully passed the certification tests with the following scope:

☑ DP-V0	MS0, Sync, Freeze
☑ Physical Layer	RS485

Test Report Number: **PCN182-DPS-01**
Authorized Test Laboratory: **PROCENTEC, Wateringen, The Netherlands**

The tests were executed in accordance with the following documents:
"Test Specifications for PROFIBUS DP Slaves, Version 3.09, September 2008".
This certificate is granted according to the document:
"Framework for testing and certification of PROFIBUS and PROFINET products".
For all products that are placed in circulation by August 22, 2016 the certificate is valid for life.

(Official in Charge)

Board of PROFIBUS Nutzerorganisation e. V.

(Karsten Schneider)

(K.-P. Lindner)

PROFI BUS®

IEC 61850 CPRI Certificate

CENTRAL POWER RESEARCH INSTITUTE

Prof. Sir CV Raman Road, PO Box 8066, Sadashivanagar PO,
BANGALORE – 560 080. I N D I A

UCA International Users Group

IEC 61850 Certificate Level A

No. UARC/SASL/C002/2014

Issued to:
M/s. LARSEN & TOUBRO LIMITED
ELECTRICAL & AUTOMATION INDEPENDENT CO,
ELECTRICAL SYSTEMS & EQUIPMENT BU
RELAYS & INTEGRATION SOLUTIONS
GATE 7, POWAI CAMPUS, MUMBAI, 400072, INDIA

For the server product:
FCOMP Feeder Control Metering & Protection Unit
Hardware Version: 1.1
Software Version: 6.0
Serial No.: ZX96022

Issued by: CENTRAL POWER RESEARCH INSTITUTE, India

The server product has not shown to be non-conforming to:
IEC 61850 First Edition Parts 6, 7-1, 7-2, 7-3, 7-4 and 8-1
Communication networks and systems in substations

The conformance test has been performed according to IEC 61850-10, the UCA International Users Group Device Test Procedures version 2.3 with Test Procedures Change List (TPCL) version 1.7, the product's protocol, model and technical issue implementation conformance statements: "PICS version 0.3", "MICS version 0.3", "TICS version 0.2" and the extra information for testing: "PIXIT version 0.4".

The following IEC 61850 conformance blocks have been tested with a positive result (number of relevant and executed test cases/total number of test cases):

1: Basic Exchange (18/24)	9b: GOOSE Subscribe (10/11)
2: Data Sets (4/6)	12a: Direct Control (3/12)
2+: Data Set Definition (23/23)	12c: Enhanced Direct Control (4/13)
5: UnBuffered Reporting (17/19)	13: Time Synchronization (3/5)
6: Buffered Reporting (19/21)	14: File Transfer (6/7)
9a: GOOSE Publish (9/13)	

This Certificate includes a summary of the test results as carried out at CPRI, Bangalore, India with UniCAsim 61850 version 4.27.04 test system running test suit "61850 Conformance Test v3.27.00" and UniCA 61850 analyzer version 5.27.04. This document has been issued for information purposes only and the original paper copy of the CPRI Report No.: UARC/SASL/T002/2014; Dated: 21-April-2014 will prevail.

The tests has been carried out on one single specimen of the products as referred above and submitted to CPRI by M/s. LARSEN & TOUBRO LIMITED ELECTRICAL & AUTOMATION INDEPENDENT CO, ELECTRICAL SYSTEMS & EQUIPMENT BU RELAYS & INTEGRATION SOLUTIONS GATE 7, POWAI CAMPUS, MUMBAI, 400072, INDIA. The manufacturer's production process has not been assessed. This Certificate does not imply that CPRI has certified or approved any product other than the specimen tested.

Bangalore,: 21-April-2014

(V. Arunachalam)
Additional Director

(Pradish M)
Test Engineer

Report Reference No: UARC/SASL/T002/2014; Dated: 21-April-2014

Level A – Independent Test Lab with certified ISO 9000 or ISO 17025 Quality System
Please Note: Hardcopy of the certificate with CPRI Hologram is only valid.

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No. UARC/SASL/C002/2014

Applicable Test Procedures from the UCA International Users Group Device Test Procedures version 2.3 with TPCL version 1.7

Conformance Block	Mandatory	Conditional
1: Basic Exchange	Ass1, Ass2, Ass3, AssN2, AssN3, AssN4, AssN5, Srv1, Srv2, Srv3, Srv4, Srv5, SrvN1abcd, SrvN4	Srv6, Srv7, Srv8, SrvN1f
2: Data Set	Dset1, Dset10a, DsetN1ae	DsetN1b
2+: Data Set Definition	Dset2, Dset3, Dset4, Dset5, Dset6, Dset7, Dset8, Dset9, DsetN1cd, DsetN2, DsetN3, DsetN4, DsetN5, DsetN6, DsetN7, DsetN8, DsetN9, DsetN10, DsetN11, DsetN12, DsetN13, DsetN14, DsetN15	--
5: Unbuffered Reporting	Rp1, Rp2, Rp3, Rp4, Rp7, Rp10, Rp12, RpN1, RpN2, RpN3, RpN4	Rp5, Rp6, Rp8, Rp9, RpN5, RpN6
6: Buffered Reporting	Br1, Br2, Br3, Br4, Br7, Br8, Br9, Br12, Br14, BrN1, BrN2, BrN3, BrN4, BrN5	Br5, Br6, Br10, Br11, BrN6
9a: GOOSE Publish	Gop2, Gop3, Gop4, Gop7, Gop9, Gop10a	Gop1, Gop10b, GopN1
9b: GOOSE Subscribe	Gos1a, Gos2, Gos3, GosN1, GosN2, GosN3, GosN4, GosN5, GosN6	Gos1b
12a:Direct Control	CtlN3, CtlN8, DOns1	--
12c: Enhanced Direct Control	CtlN3, CtlN8, DOes2, DOes5	--
13: Time Synchronization	Tm1, Tm2, TmN1	--
14: File Transfer	Ft1, Ft2ab, Ft4, FtN1ab	Ft2c, FtN1c

(V. Arunachalam)
Additional Director

(Pradish M)
Test Engineer

Report Reference No: UARC/SASL/T002/2014; Dated: 21-April-2014

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